L. L. Smith
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SCIENCE ABSTRACTS

SECTION A

PHYSICS.

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ABSTRACTORS

G. E. Allan, D.Sc.
H. N. Allen, B.Sc.
R. H. Allen, B.Sc.
C. B. Allsopp, M.A., Ph.D.
J. P. Andrews, D.Sc., F.Inst.P.
R. d'E. Atkinson, M.A., Ph.D.
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E. H. W. Banner, M.Sc., A.M.I.E.E., F.Inst.P.
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F. J. Brislee, D.Sc., F.I.C.
H. L. Brose, D.Sc., Ph.D., M.A., F.Inst.P.
H. M. Browning, M.Sc., Ph.D., F.Inst.P.
L. G. Carpenter, B.A., B.Sc.
L. V. Chilton, M.A., A.Inst.P.
J. E. R. Constable, Ph.D., M.A., B.Sc.
A. Daniell, M.A., D.Sc.
N. Davy, B.Sc., A.R.C.Sc.
M. A. Evershed, F.R.A.S.
J. Ewles, M.A.
L. B. Firnberg, B.Sc. (Eng.), A.C.G.I.
E. E. Fournier d'Albe, D.Sc., F.Inst.P.
R. C. Fox, Ph.D., B.Sc. (Eng.).
G. F. Freeman, M.Sc. (Eng.).
W. H. George, M.Sc., Ph.D.
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J. W. T. Walsh, M.A., D.Sc.
F. J. Wilkins, M.Sc., Ph.D.
A. Wilkinson, B.Sc.
A. B. Wood, D.Sc.

ERRATA

Section A.—PHYSICS.

Abstract No. 39, line 13; *for* isobars, *read* isobares.
Abstract No. 64, lines 4 and 6; *for* election, *read* electron.

SCIENCE ABSTRACTS.

Section A.—PHYSICS.

AUGUST, 1932.

GENERAL PHYSICS.

2653. Comparison of Gaseous Densities by the Method of Balancing Columns. A. H. Snell and A. N. Shaw. *Canad. J. of Research*, 6. *pp.* 309–321, *March*, 1932.—An application of the principle of balancing columns to the comparison of gaseous densities at any ordinary pressure is described. The precision of a given apparatus depends upon the heights of the columns, on the sensitivity of the pressure gauge and on the extent of uncontrolled fluctuations in temperature. Without a thermostatic control and employing a simple modified form of the Toepler micromanometer with columns 12 m. in height, a sensitivity of 10^{-7} gm. per c.c. is obtained. The apparatus and the technique are explained in detail, with a discussion on the elimination of errors. An application of the method is made in the field of hygrometry, and its usefulness in the measurement of air-gas ratios is also explained and recommended. An advance in precision is obtained, primarily by the use of an improved form of Toepler micromanometer. AUTHORS.

2654. Flexure Balance. K. S. Cole. *Rev. Sci. Instruments*, 3. *pp.* 121–122, *March*, 1932.—A fibre is clamped at one end and is free at the other. By the proper motion of the clamped end, the flexed fibre gives a force at the free end in the required direction. Owing to its simplicity it can be applied to ordinary torsion-balance work. H. M. B.

2655. Measurements with the Pressure Balance. Part II. J. A. Beattie and O. C. Bridgeman. *Ann. d. Physik*, 12. 7. *pp.* 827–836, *March* 4, 1932.—This paper continues the work of Part I [see Abstract 672 (1932)], and deals with the effect of ageing and oil viscosity on the balance constants. An investigation is also included of the dimensional relationships of the balance parts and their effect upon accuracy. H. H. Ho.

2656. Influence of Radius of Knife Edge on the Sensitivity of the Lever Balance. G. Schmerwitz. *Phys. Zeits.* 33. *pp.* 234–239, *March* 15, 1932.—The author seeks to rectify a series of vaguely defined and false ideas regarding the ordinary lever balance. The influence of sagging is most frequently present, but not evident. The neglected influence of the radius of curvature of the section is shown theoretically and experimentally in some actual examples. The irregularity of this radius of curvature shows itself as one of the main causes for the oscillation of the zero with large sensitivity. The consequences of these results are

shown for a constructive improvement of the ordinary lever balance, and for a new construction which gives a higher accuracy of measurement.
R. S. R.

2657. Conchoidal Pendulum. W. Meyer zur Capellen. *Zeits. f. Instrumentenk.* 52. *pp.* 123–128, *March*, 1932.—Diagrams indicate the method of producing conchoidal motion. A theory, using Lagrange's equations, leads to formulæ for the velocities at various points in the moving plane. By limiting the initial velocity the system becomes oscillatory, and a theoretical period of vibration is calculated. In practice friction considerably alters the conditions. H. M. B.

2658. Instrument for Measuring Very Small Differences in Gravity. K. Hartley. *Physics*, 2. *pp.* 123–130, *March*, 1932.—Description of a new portable instrument for measuring relative values of gravity to within two or three parts in ten millions, specially designed for geophysical exploration. The principles of the design are analysed and the methods for eliminating effects of elastic hysteresis, temperature changes, variations in barometric pressure, etc., are discussed. Also effects of initial stresses in materials, defects in alignment of locking mechanism, inaccurate levelling, etc. These difficulties are serious, but seem to have been overcome. Results of preliminary field measurements near Houston, Texas, are presented, and some comparison between the type of information given by this instrument and by the torsion balance. AUTHOR.

2659. Surface Tension of Gold Laminæ. G. Tammann and W. Boehme. *Ann. d. Physik*, 12. 7. *pp.* 820–826, *March* 4, 1932.—The temperature at which gold laminæ of thickness $0{\cdot}2$–$0{\cdot}8\,\mu$ commence to shrink has been determined by direct measurement of the changes of length consequent on increase of temperature. For beaten foil the temperature lies about 200° higher than that observed for electrolytically prepared foil, probably because of the irregular thickness of the former. The rate of shrinkage falls with time from a relatively high value to a constant value after about 15 min.; the initial rate bears a linear relationship to the temperature, and diminishes with increasing thickness of the film. Study of the rate of shrinkage—load curves yields for the surface tension of the films at 700° C. 1230 mg./cm., and at 850° C. 1180 mg./cm. H. F. G.

2660. Surface Tension and Density of Nitric Oxide. G. H. Cheesman. *Chem. Soc., J. pp* 889–890, *March*, 1932.—Measurements are made between $-147°$ C. and $-162{\cdot}5°$ C. The gradient of the Ramsay Shields function is found to be greater than for non-associated liquids. The parachor $P = M^{1/4}/(D - d)$, where $M = 30$, is not constant, but rises with temperature, and is considerably higher than that calculated from the sum of the atomic constants. H. M. B.

2661. Surface Tensions of Mixtures of Normal Propyl Alcohol and Benzene. R. C. Brown. *Phil. Mag.* 13. *pp.* 578–584, *March*, 1932.—Apparatus for the accurate measurement of the surface tensions of mixtures of volatile liquids employing Jaeger's maximum bubble-pressure method is described. The value of T, the surface tension of benzene, was found to be $28{\cdot}89 \pm 0{\cdot}04$ dyne/cm. at $20{\cdot}00 \pm 0{\cdot}02°$ C. The value of T for normal propyl alcohol at 20° C. was found to be $23{\cdot}78$ dyne/cm. The surface tension-percentage composition graph exhibits a definite point of inflection in the region of composition corresponding to

7 % of propyl alcohol. This region corresponds to the range over which Dunstan found that the viscosities of mixtures of the substances are below those of the pure substances. The maximum deviation of the graph from a straight line corresponds with a mixture containing 34 % of the alcohol. On Denison's theory this suggests that molecular groups of composition $3C_6H_6 . 2C_3H_8O$ are present. J. S. G. T.

2662. New Types of Surface-Tension Meter. K. Grant. *Journ. Sci. Instruments*, 9. *pp.* 108–109, *March*, 1932.—Two simple surface-tension meters are described, in which the tension is balanced in the one case by gravity and in the other by the elastic torque in a wire. The instruments are not suited for the detection and measurement of changes of surface tension in liquids due to temperature, contamination, films of other liquid or gas, etc. AUTHOR.

2663. Double Capillary Method for the Measurement of Interfacial Tension. G. L. Mack and F. E. Bartell. *Am. Chem. Soc., J.* 54. *pp.* 936–942, *March*, 1932.—A description is given of four modifications of a double capillary rise method for the measurement of interfacial tension between water and another liquid when only small quantities (2–4 c.c.) of the liquid are available. In the first two types it is not necessary to determine the density of the organic liquid accurately, but for the others it must be obtained with precision. Good agreement for reference liquids is seen when results are compared with those generally accepted. H. M. B.

2664. New Method of Measuring Molecular Films. E. Gorter and W. A. Seeder. *Kolloid Zeits.* 58. *pp.* 257–260, *March*, 1932.—An optical arrangement gives an image of a straight filament of a lamp when the light is reflected from a stationary surface. When standing waves are formed on the surface, the image of the filament spreads into a band, and from the width of this and the constants of the optical system, the wavelength and the amplitude of the waves are calculated. Films of oils and fats are spread on the liquid surface, and the amplitude of the waves obtained for different spreadings. Graphs illustrate the results and show that for a particular thickness of the film (which varies according to the material used) the amplitude of the waves, and therefore the surface tension are zero. H. M. B.

2665. Thin Films and their Physical Characteristics. H. Devaux. *Kolloid. Zeits.* 58. *pp.* 129–143, *Feb., and pp.* 260–276, *March*, 1932.—A review, with Bibliography, of surface phenomena, particularly dealing with the effects of thin films on various liquids and solids. A brief *résumé* is given of methods of measuring depths of invisible films of molecular thickness. Tables and diagrams compare theoretical and experimental values. The properties (optical, mechanical, etc.) of the films are discussed, and their behaviour (adhesion, wetting, etc.) recorded with regard to the bodies with which they are in contact. Orientation of the molecules is considered, and the effects of these properties on animate and inanimate objects are mentioned. H. M. B.

2666. Phenomenon of Capillary Chemistry. R. Dubrisay. *Comptes Rendus*, 194. *pp.* 1076–1077, *March* 21, 1932.—This paper contains a record of experiments which show that in a solution of several substances which have different effects on the surface tension of the solvent, the enrichment at the free surface is most pronounced in the substance which lowers the surface tension most. H. H. Ho.

2667. Properties of Porous Building Materials. Parts III and IV. E. Madgwick. *Phil. Mag.* 13. *pp.* 632–650, *March*, 1932.—The movement of water in a porous body is considered theoretically, on the assumption that resistance to flow is proportional to the average velocity of flow, and equations are presented for several particular cases of practical occurrence. In Part IV the theory is used to interpret observations on a typical homogeneous stone. [For Parts I and II see Abstract 1483 (1932).] J. H. A.

2668. Slow Motion of a Fluid. W. R. Dean. *Phil. Mag.* 13. *pp.* 585–600, *March*, 1932.—A fluid flows in a parallel-sided channel, into which a baffle projects perpendicularly from the walls. The general character of the two-dimensional motion of the fluid is worked out by a method of biharmonic analysis due to A. E. H. Love. J. P. A.

2669. Equations of Motion of a Viscous Fluid. J. Prescott. *Phil. Mag.* 13. *pp.* 615–623, *March*, 1932.—The exact equations of motion, in their customary form, are deduced in a somewhat new way, involving only the assumption that in laminar flow the viscous drag is proportional to the velocity gradient. J. H. A.

2670. Linear Translation of a Sphere in a Real Liquid. I. Kobayshi. *Tohoku Univ. Sci. Reports*, 21. *pp.* 88–95, *March*, 1932. *In German.*—A purely mathematical analysis for the case of a system initially at rest. In addition to the principal motion there is always set up a superimposed perturbation which dies away only very slowly. H. F. G.

2671. Transition from the Viscous to the Hydraulic Régime in the Case of the Translatory Motion of a Solid in Water. R. Serville. *Comptes Rendus*, 194. *pp.* 840–843, *March* 7, 1932.—Characteristics of the translatory motion of a system consisting of a circular disc, sphere, hollow hemisphere or cone in water are investigated experimentally. J. S. G. T.

2672. Similitude of Vortices. C. Camichel, L. Escande and G. Sabathe. *Comptes Rendus*, 194. *pp.* 1048–1051, *March* 21, 1932.—In continuation of previous work [see Abstract 1500 (1926)], the Reech-Froude principle of similitude is found to apply to the efflux of water through an orifice at the bottom of a vessel in which the water was constrained to flow in a spiral-cylindrical vortex having vertical generating lines. J. S. G. T.

2673. Stationary Vortices in Sheared Fluid Streams. W. Lange. *Ann. d. Physik.* 13. 1. *pp.* 9–37, *March* 26, 1932.—The author discusses mathematically examples of fluid motion which afford a clear picture of the processes concerned as the limit of stability of fluid motion is attained. First viscosity is neglected, and then the effect of viscosity considered with the limitation that a state of stability still persists in the motion. Departures from the stable condition in the absence of viscous forces are next discussed, and finally a qualitative picture of the phenomenon with both effects present is discussed. J. S. G. T.

2674. Theory of the Small Oscillations of a Vortex Filament of Approximately Circular Form. T. Levi-Civita. *Accad. Lincei, Atti*, 15. *pp.* 409–416, *March* 20, 1932.—Purely mathematical. H. F. G.

2675. Instability of Helicoidal Vortices. G. Lampariello. *Accad. Lincei, Atti*, 15. *pp.* 432–436, *March* 20, 1932.—Purely mathematical. H. F. G.

2676. Flow of Air through Circular Orifices in Thin Plates. J. A. Polson and J. G. Lowther. *Univ. Illinois Eng. Exp. Sta., Bull. No.* 240. [37 *pp.*], *Jan.* 29, 1932.—The flow of air through square-edged circular orifices of nominal diameter 0·5–2·5 in. formed in thin plates at pressures up to 35 in. of mercury is investigated experimentally. The coefficients of discharge, *i.e.*, the rate of the weight of air actually discharged to that calculated from Durley's equation, increases with increasing inlet pressure up to a critical pressure. Graphs showing the relation of the coefficient of discharge to the size of orifice have all the same general characteristics, their slope increasing with increased inlet pressure. For work in which a tolerance of 1 % is permissible, all the coefficients may be derived from a single straight line. Square-edged orifices must be carefully used. Very slight injury to the entrance edge may affect the discharge coefficient to the extent of 2–3 %. J. S. G. T.

2677. Flow of Gas at Very Low Pressure through Tubes of Various Lengths. P. Clausing. *Ann. d. Physik*, 12. 8. *pp.* 961–989, *March* 10, 1932.—Shows that Dushman's formula for long cylindrical tubes gives only a rough approximation for short tubes, and that a strict solution for a tube of any length can be obtained from an integral equation which depends on geometrical probabilities. Gives a table which can be used in practical cases, which makes it easy in the case of every high-vacuum pump to obtain a quantitative idea of the velocity of pumping. Where gas is produced in the apparatus it is possible to calculate the final stationary pressure. H. N. A.

2678. Flow of a Compressible Fluid in the Neighbourhood of the Throat of a Constriction in a Circular Wind Channel. S. G. Hooker. *Roy. Soc., Proc.* 135. *pp.* 498–511, *March* 1, 1932.—G. I. Taylor's work [see *Aero. Res. Ctee.*, No. T. 2904, 1930] on the irrotational flow of a non-viscous compressible fluid past convex surfaces is discussed in relation to that of T. E. Stanton [see *Aero. Res. Ctee.*, No. T. 2956, 1930] on the flow of air through a constriction in a parallel pipe, and a mathematical investigation is given of the cause of the discrepancy between the numerical differences of the critical values determined in the two cases. It is shown that, in conformity with the two-dimensional solution, there is a limit to the maximum velocity which can occur in symmetrical flow through an orifice. A solution is given also for the case in which the velocity increases continuously down every stream tube. H. F. G.

2679. Speed of Extraction of Condensation Pumps. M. Matricon. *J. de Physique et le Radium*, 3. *pp.* 127–144, *March*, 1932.—The author develops a theory in which he shows that the speed of extraction of a condensation pump at low pressures is constant, and is proportional to the area A of the zone of diffusion, and inversely proportional to the square root of the molecular mass of the extracted gas. Thus the speed of extraction $S = CA/\sqrt{2\pi\rho}$, where C is a characteristic constant of the moving fluid (mercury) with a value 9×10^{-2} and ρ = density of the extracted gas at a pressure of one " barye " (1/10 atmosphere). This result permits of a predetermined value of the speed of extraction of a given pump. It is also shown that the pressure limit of such a pump is given by the formula $p_0 = p_1 e^{-aL/D_0}$, where p_1 is the initial pressure, a the rate of flow of the mercury vapour, L the effective length of the tube, and D_0 the coefficient of diffusion of the very dilute gas when the concentration of the mercury is 1 molecule per c.c. T. B.

2680. Multiple Nozzle Diffusion Pumps. T. L. Ho. *Rev. Sci. Instruments*, 3. *pp.* 133–135, *March*, 1932.—The effect of the number of nozzles on the speed of mercury diffusion pumps is considered. The efficiency of a multiple nozzle pump is found to be greater than that of a single nozzle pump of the same size. Designs are given for four- and seven-nozzle pumps. With a nineteen-nozzle pump a speed of 320 litres per sec. is obtained. J. T.

2681. Diffusion of Copper in Gold. W. Jost. *Zeits. f. phys. Chem.* 16. *Abt.B.* 2–3. *pp.* 123–128, *March*, 1932.—The diffusion of copper in gold is measured by an X-ray method. Copper wires are gold-plated and maintained at a high temperature (about 500° C.) for varying periods. Powder photographs are taken and observations are made on the (511) reflections. When no diffusion has taken place the lines of copper and gold occur separately. When the diffusion is slight, a bend is obtained corresponding to a continuous variation of lattice parameter from that of pure gold to that of pure copper. As diffusion proceeds the ends of the band correspond to different concentrations from before and a shift of the band occurs. From the amount of this shift the concentrations corresponding to the end points and hence the diffusion constant are determined. J. T.

2682. Measurement of Diffusion Coefficients. Y. Nisizawa. *Chem. Soc., Japan, Bull.* 7. *pp.* 72–84, *March*, 1932. *In German.*—The diffusion coefficients of a number of substances, such as potassium salts of the fatty acids, cellulose acetate and various cellulose nitrates, into the pure solvent have been determined by placing either the solid or a concentrated solution in a tall glass cylinder, adding a layer of solvent, and observing the rate at which a very small aerometer rises through the liquid. The method is very accurate. The application of measurements of this type to determination of the molecular size of cellulose derivatives is discussed. The results indicate that the degree of aggregation of nitrocellulose which has been heated to 100° C. is much less than that of normal cotton, and this view is confirmed by viscosity measurements. H. F. G.

2683. Flow Pressure of Metals at Low Temperatures. R. Holm and W. Meissner. *Zeits. f. Physik*, 74. 11–12. *pp.* 736–739, *March* 11, 1932. *From the Reichsanstalt.*—In connection with their paper on contact resistance between supraconductors [see Abstract 2961 (1932)] the authors have investigated at low temperatures, by means of the hard-ball method, the size of the contact surface of contacts which are loaded until the softer metal is indented, the metal flowing under pressure. Measurements have been made with Au, Pt, Ag, Pb, Sn and Cu. The form of the indentations is described. They are not in general perfect spherical cups. The flow pressure increases rapidly with falling temperature, to the greatest extent with Ag and less with Au. H. N. A.

2684. Flow Capacity of Alloys. A. Portevin and P. Bastien. *Comptes Rendus*, 194. *pp.* 850–853, *March* 7, 1932.—The flow capacity depends on the course of solidification defined by the solidification curves and the form of crystallisation which conditions the movement of the crystals and their fixing in the mould. The experiments described were limited to alloys of easily fusible metals—Sn, Sb, Pb, Cd, etc.,—and $\Theta - F$, was kept constant (Θ temperature of flow, F temperature of commencement of solidification), since to a first approximation the flow capacity increases proportionally to this interval sometimes called "superheated

liquid." From the results the two following laws were deduced: (1) The flow capacity varies inversely as the interval of solidification, and shows a relative maximum when the fusion is congruent—pure metals, eutectics, maximum of the liquidus—and is a minimum for saturated solid solutions. (2) The flow capacity depends on the form of solidification, and is relatively much greater when the liquid gives rise to convex crystals (definite compounds) than when dendrites are formed (solid solutions approximating to pure metals). J. J. S.

2685. Plastic Deformation in Theory and Experiment. E. Siebel. *Stahl u. Eisen, Nov.* 26, 1931. *Engineer* (*Metallurgist*), 143. *pp.* 22–24, *Feb.* 26, 1932.—It is pointed out that the theoretical treatment of the laws relating to the plastic deformation of metals is beset by many difficulties, but that considerable advances have been made and a survey of the present position is given by the author. The theoretical treatment of the subject, based on the assumption that a parallelepiped of the unstrained material remains a parallelepiped after deformation, is discussed, and is illustrated diagrammatically, the defects in the theory being indicated. Recent investigations aiming at the separate determination of each of the losses of energy that occur in plastic deformation, and, in addition to the measurement of the external forces, at establishing the conditions of stress that exist during deformation are considered in detail. Attention is drawn to the fact that a knowledge of the stress distribution obtained in the manner set forth in the investigations described is of considerable importance for understanding the behaviour of metals during rolling. P. A. L.

2686. Recent Researches on Plasticity. *Engineer* (*Metallurgist*), 143. *pp.* 25–27, *Feb.* 26, *and pp.* 34–37, *March* 25, 1932.—The author points out the importance of a knowledge of plastic conditions in connection with certain processes, such as forging, rolling, etc., and draws attention to the lack of information available until recently in this direction. The recent work of various investigators is mentioned, that of Lodé and v. Mises being discussed, and the latest researches of Taylor and Quinney being described in detail. Reference is made to an important book on the subject by A. Nadei. The maximum stress theory, the maximum strain theory, the theory of constant total energy of deformation, the maximum shear theory, Mohr's theory and v. Mises' theory are considered comparatively, and the bearing of Taylor and Quinney's work thereon is discussed in detail, a full account of the experiments of the latter investigators being given in Part II of the article. The view is expressed that v. Mises' theory, backed by Lodé's experiments, is of very great importance in the study of plasticity. The experimental results attained by Taylor and Quinney comprise (*a*) orientation of the principal axes of stress and strain, (*b*) comparison between v. Mises' first hypothesis for the condition for the commencement of plastic distortion and Mohr's hypothesis and (*c*) the relationship between ratios of principal shear stresses and ratios of corresponding principal strains (v. Mises' second hypothesis). P. A. L.

2687. Heat Treatment of Fine Metallic Suspensions. N. N. Zirbel. *Physics*, 2. *pp.* 134–138, *March*, 1932.—When a suspended system is supported by a fine wire the equilibrium position usually changes slowly for a long time after the load is applied. The equilibrium position

also changes with temperature. It is found that both of these disturbing factors can be eliminated by a suitable heat treatment of the wire. Observations have been made on tungsten and platinum-iridium wires of sizes suitable for use in the Eötvös torsion balance. AUTHOR.

2688. Rate of Deformation of a Loaded Bar. H. Deutler. *Phys. Zeits.* 33. *pp.* 247–259, *March* 15, 1932.—The rate of deformation, under carefully standardised conditions, of iron and copper test-bars is automatically recorded together with the instantaneous load. The rate may be varied over wide limits. It is found that the load is a linear function of the logarithm of the deformation velocity, in agreement with the theory of Prandtl. J. P. A.

2689. Stresses in a Plate with Two Holes. S. Yokota. *Faculty of Eng., Tokyo, J.* 20. *pp.* 101–113, *March,* 1932.—In an infinite plate two circular holes of different radii are bored. The stress distribution for boundary conditions of a general character is analysed, a special example worked out in detail and fully illustrated by diagrams. J. P. A.

2690. Special Examples of the Elastic Ring Acted upon by Equal and Equiangular Radial Forces. C. E. Larard. *Phil. Mag.* 13. *pp.* 705–710, *March,* 1932.—In a previous paper [see Abstract 3692 (1931)] the author has obtained general expressions for the two flexural moments on radial sections and for the two maximum radial strains of an elastic ring acted upon by equal and equiangular radial forces. Particular values of these moments and strains are now calculated for the cases when the number of forces is 2, 3, 4, 5 . . . to 16 respectively. Values of the minimum radial strain for the several cases are also calculated. J. S. G. T.

2691. Vibrations in Solid Structures. P. S. Rini. *Comptes Rendus,* 194. *pp.* 955–957, *March* 14, 1932.—The vibrations of large structures like the members of a bridge may be completely analysed by forming an electrical condenser, one plate of which is the surface of the structure, and the second an auxiliary metal plate. High-frequency oscillations generated in a circuit containing this condenser are modulated by the vibrations to be investigated, and this affords an accurate means of detection and measurement. J. P. A.

2692. Experimental Determination of the Damping Couple of an Oscillator. J. Haag. *Comptes Rendus,* 194. *pp.* 838–840, *March* 7, 1932.—A mathematical analysis enabling the magnitude of the damping couple operating upon an oscillating system to be derived from observations of the decrement of the oscillations and of periods of oscillation is given. J. S. G. T.

2693. Discrimination of Differences of Frequency of Vibration by the Sense of Touch. W. H. Roberts. *Frank. Inst. J.* 213. *pp.* 283–311, *March,* 1932.—An investigation of tactile perception of vibrations. An apparatus is described which will provide known changes of frequency and amplitude on depressing a key. The author estimates the smallest difference of frequency which is perceptible by the sense of touch, using various differences of intensity between the two frequencies which are being compared. The investigations are grouped around a frequency of 400 ~. A special method of analysing the observations is developed. The amplitudes were varied between 92 % and 108 % of the standard.

It is shown that a higher frequency is more easily distinguished from a lower if the higher frequency has the smaller amplitude. Discrimination was obtained for frequency differences as small as $2\frac{1}{2}$ % in the 400-cycle region. There is a good Bibliography. J. E. R. C.

2694. Motion in the Neighbourhood of Equilateral Points of Libration. H. C. Plummer. *Roy. Astron. Soc., M.N.* 92. *pp.* 442–448, *March*, 1932.—Some results on the infinitesimal motions in the immediate neighbourhood of the equilateral points of libration in the general problem of three bodies are given. All possible values of the mass-ratios are considered. The paper is highly mathematical. G. C. McV.

2695. Unsymmetrical Heavy Tops. H. Gebelein. *Ann. d. Physik*, 12. 8. *pp.* 889–926, *March* 10, 1932.—Works out a new theory. The paper comprises: (1) Euler's angle and the Eulerian equations; (2) approximate solutions of the top equations (first approximation, second approximation, infinitely close approximation); (3) the upright top; (4) the construction of a top-model; and (5) experimental data. Several incidental conclusions are reached, notably a class of purely periodic movements which form pure precessions. The experimental work is illustrated by photographs, which agree with the formulæ deduced. A. D.

2696. Simplified Method of Calculating Tangents by the Theory of Least Squares. F. T. Gucker, Jr., and H. J. Brennen. *Am. Chem. Soc., J.* 54. *pp.* 886–888, *March*, 1932.—By choosing equally spaced positive and negative values of the independent variable and making the y-axis pass through the point at which the tangent is required, $dy/dx = \Sigma xy/\Sigma x^2$. Tangents may thus be calculated more rapidly and accurately than by graphical means. In illustration, the calculation of ten values of the coefficient of thermal expansion of a salt solution from the density at five different temperatures is given. H. F. G.

2697. Crystal Structure of Praseodymium. A. Rossi. *Accad. Lincei, Atti*, 15. *pp.* 298–300, *Feb.* 21, 1932.—The values found for the ratios between the lattice planes of the Pr crystal and the order of reflection agree closely with those calculated for a hexagonal system, the value of the axial ratio $c:a$ being 1·60, and the side of the unit cell $a_0 = 3{\cdot}657$ Å. Three weak lines, occurring in the best of the photograms obtained and not corresponding with such an hexagonal system, are regarded as due to impurities. The value given in the literature for the density of Pr is 6·60; that found for the material examined (99·4 % of Pr) is $6{\cdot}765 \pm 0{\cdot}008$, the calculated density being 6·777. T. H. P.

2698. Crystal Structure of Lead Fluorochloride, PbFCl. W. Nieuwenkamp and J. M. Bijvoet. *Zeits. f. Krist.* 81. 5–6. *pp.* 469–474, *March*, 1932.—The coordinates are Pb: $00u$, $\frac{1}{2}\frac{1}{2}\bar{u}$, $(u = 0{\cdot}020_5)$; F: $\frac{1}{2}00$, $0\frac{1}{2}0$; Cl: $00w$, $\frac{1}{2}\frac{1}{2}\bar{w}$, $(w = 0{\cdot}65)$; space group D^7_{4h}. The crystal is thus built up of alternating layers Pb–F–Pb–Cl–Pb–. The F layers are planar, the Cl layers non-planar. F. I. G. R.

2699. Preparation and Crystal Structure of Normal (Meta-) Silver Periodate. L. Birckenbach and F. Buschendorf. *Zeits. f. phys. Chem.* 16. *Abt.B.* 2–3, *pp.* 102–112, *March*, 1932.—Two new methods for the preparation of $AgIO_4$ are given and its analysis is described. It forms tetragonal, bipyramidal, yellow crystals similar to scheelite, and is optically positively uniaxial. The crystal structure has been determined by the Debye–Scherrer method, and isomorphism with tetragonal crystals of

the scheelite type has been demonstrated by comparison of the intensities. The space group is C_{4h}^6, and the lattice dimensions are $a_0 = 5{\cdot}368 \pm 0{\cdot}02$ Å., $c_0 = 12{\cdot}013 \pm 0{\cdot}03$ Å., $c_0 : a_0 = 2{\cdot}238$. The mean density (pyknometric) is 5·57 (X-ray value 5·74), corresponding with four molecules in the unit cell. T. H. P.

2700. Crystal Structure of Benzene. E. G. Cox. *Roy. Soc., Proc.* 135. *pp.* 491–498, *March* 1, 1932.—Extension of the previous work to the consideration of the intensities of the X-ray reflections from various lattice planes has rendered possible calculation of the structural arrangement of the molecules in the lattice. The most probable structure is that in which the plane of the ring is approximately parallel with the *b* axis and at an angle of about 40° with the 100 plane. The molecule almost certainly takes the form of a flat ring, the distance between the carbon atoms in neighbouring molecules being about 3·8 Å., compared with 3·5 Å. found for most other organic compounds. H. F. G.

2701. Crystal Structure of Thiourea. R. W. G. Wyckoff and R. B. Corey. *Zeits. f. Krist.* 81. *pp.* 386–395, *March*, 1932. *In English.*—Demény and Nitta's results [see Abstract 2591 (1928)] are substantially confirmed, but axes coinciding with the crystallographic axes are here used. The coordinates are:

$$\text{C and S } \{uv\tfrac{1}{4};\ \bar{u}\bar{v}\tfrac{3}{4};\ \tfrac{1}{2}-u, v+\tfrac{1}{2}, \tfrac{1}{4};\ u+\tfrac{1}{2}, \tfrac{1}{2}-v, \tfrac{3}{4}\}$$

with $u_c = -0{\cdot}14$, $v_c = 0{\cdot}10$, $u_s = 0{\cdot}12_0$, $v_s = -0{\cdot}00_7$.

$$\text{N } \left\{\begin{matrix} xyz;\ \bar{x}, \bar{y}, z+\tfrac{1}{2};\ \tfrac{1}{2}-x, y+\tfrac{1}{2}, \tfrac{1}{2}-z;\ x+\tfrac{1}{2}, \tfrac{1}{2}-y, z; \\ \bar{x}\bar{y}\bar{z};\ x, y, \tfrac{1}{2}-z;\ x+\tfrac{1}{2}, \tfrac{1}{2}-y, z+\tfrac{1}{2};\ \tfrac{1}{2}-x, y+\tfrac{1}{2}, z. \end{matrix}\right\}$$

with $x = 0{\cdot}27_8$, $y = -0{\cdot}13_0$, $z = -0{\cdot}12_5$.

The atoms in the molecule lie in one plane, with interatomic distances, C – N 1·35, N – N 2·24 Å., almost identical with those in urea (1·33 and 2·18), C – S = 1·64 Å. In different molecules, N – S = 3·45, N – N = 3·85 Å. The grouping is pictured. C. A. S.

2702. X-Ray Analysis of the Crystals of 1:4 Di-iodocyclohexane and 1:4 Dibromocyclohexane. E. Halmöy and O. Hassel. *Zeits. f. phys. Chem.* 16. *Abt.B.* 2–3. *pp.* 234–248, *March*, 1932.—This determination of the crystal structure of two 1 : 4 derivatives of cyclohexane forms part of a systematic physico-chemical investigation of cyclohexane derivatives to provide material for the structural study of the hydro-aromatic six-membered rings. The dihalides in question have either a zero dipole moment in benzene solution or at all events one which is very small, so that it appears not improbable that their molecules have a symmetrical configuration in the solid state, and in consequence the di-iodide data may permit of a more exact localisation of the halogen atoms with contingent information concerning the form of the carbon framework. The crystallographic and X-ray measurements are included in the present paper, together with the coordination data for the iodine atoms and a comprehensive discussion of the results obtained. H. H. Ho.

2703. X-Ray Investigation of the Crystals of o-Azotoluene. M. Prasad and K. V. Desai. *Phil. Mag.* 13. *pp.* 600–603, *March*, 1932.—The structure of crystals of *o*-azotoluene has been examined by the rotating crystal method. The dimensions of the unit cell are found to be: $a = 13{\cdot}93$ Å., $b = 6{\cdot}604$ Å., $c = 14{\cdot}55$ Å., $b = 101°{\cdot}4'$. The cell

contains four molecules. The crystal belongs to space group C_{2h}^5 and Γm lattice. No complete symmetry about $(20\bar{1})$ has been observed, as in the case of azobenzene, but the value of $c \sin \beta$ in this crystal is the same as in that of azobenzene. AUTHOR.

2704. X-Ray Investigations of Liquid Crystals. Part IV. K. Herrmann and A. H. Krummacher. *Zeits. f. Krist.* 81. 5–6. *pp.* 317–332, *March*, 1932.—An apparatus is described whereby the smectic or the nematic state of a substance can be established with certainty, and with it the following substances have been studied: azoxybenzoic acid ethyl ester, phenetoleazoxybenzoic acid allyl ester, para-ethoxybenzalaminocinnamic acid methyl ester, phenylbenzalaminocinnamic acid ethyl ester, and terephthalicbisaminocinnamic acid ethyl ester. The X-ray photographs obtained in all cases are similar to those described by G. and E. Friedel for azoxybenzoic acid ethyl ester. [For Part III see Abstract 3700 (1931).] H. H. Ho.

2705. Stability of Heteropolar Crystals. H. M. Evjen. *Phys.* Rev. 39. *pp.* 675–687, *Feb.* 15. 1932.—On the basis of the conventional model of heteropolar crystals it is shown that an irregular crystalline behaviour is to be expected in the region of small values of the exponent, p, of the repulsive energy. In the course of this demonstration Madelung's method of obtaining the Coulomb potential for the crystals of the cubical system is justified, and a new, very simple method of calculating the Madelung constant is described. This method is applied to the three crystals of the cubical system and other applications are suggested. The irregular behaviour of crystals in the region of small values of the repulsive exponent is shown to be manifested as an instability against various variations by which the geometry of the lattice is altered. In particular, the instability is demonstrated in the case of the "calcite family" of crystals which is evolved by a continuous process from a single parameter ϕ. The NaCl and CsCl types of crystals are members of this family, and a continuous mode of transition from one to the other is thus available. These two types of crystals, in general, are unstable against a variation in which the parameter ϕ is changed (ϕ-variation), and for small values of the exponent, p, all members of the "calcite family" are shown to have a tendency to fall apart into one-dimensional crystals of the Madelung type. Another result of these considerations is that a skew structure, such as that of calcite, may be accounted for on the basis of purely central forces. Finally, the regions in which respectively one-dimensional and two-dimensional crystals and the crystals of the cubical system are most stable are calculated. The bearing of these results on the theory of the secondary structure is briefly discussed. AUTHOR.

2706. Vicinal Surfaces and Edges of Crystals. G. Kalb. *Zeits. f. Krist.* 81. 5–6. *pp.* 333–341, *March*, 1932.—The author gives nine "rules," the outcome of his observations, of which the last is of general application. It states that the positions of the vicinal surfaces correspond to the chief development zones of a crystal species, so that these surfaces give support to the form-development observations. F. I. G. R.

2707. Significance of Vicinal Phenomena for Crystal Measurement. G. Kalb. *Zeits. f. Krist.* 81. 5-6. *pp.* 342–351, *March*, 1932.—It is claimed that the deviations commonly observed in the measurements

of crystal angles, which are usually attributed to imperfections in growth, are capable of being interpreted in terms of the crystal faces as definite characteristics. Investigations into barytes and scolecite are cited in support. F. I. G. R.

2708. Arrangement of Micro-Crystals in Copper and Gold Deposited by Electrolysis. H. Hirata and Y. Tanaka. *Kyoto Coll. Sci., Mem.* 15. *pp.* 9–22, *Jan.*, 1932. *In English.*—The arrangements of the micro-crystals in electrolysed specimens of copper and gold deposited under various conditions were examined with X-rays by the so-called "transmission method." The experimental results thus obtained were found to agree well with those obtained by other experimenters in many respects. But in some respects, especially with regard to the direction of the growth of the deposited copper and that of the largest face of the specimen, some slight modifications are found to be needed in the conclusions arrived at up to the present time. [See Abstract 544 (1927).]

AUTHORS.

2709. Arrangements of Micro-Crystals in the Film of Molybdenum Obtained by Deposition. T. Fujiwara. *Kyoto Coll. Sci., Mem.* 15. *pp.* 31–33, *Jan.*, 1932. *In English.*—By means of Laue-photographs the arrangement of the micro-crystals in the thin film of molybdenum obtained by deposition was studied. It was found that they are composed of micro-crystals which are so arranged that the [110] plane is almost in the flat surface of the film and a cube edge is nearly parallel to the lengthwise direction, but some of them are composed of somewhat large micro-crystals, which are arranged fibrously with the [110] axis as fibre axis which is normal to the flat surface of the film. AUTHOR.

2710. Arrangement of Micro-Crystals in Compressed Single-Crystal Plates of Aluminium. Part. IV. Y. Fukami. *Kyoto Coll. Sci., Mem.* 15. *pp.* 23–30, *Jan.*, 1932. *In English.*—When rectangular single-crystal plates of aluminium were thoroughly compressed, the manner of the fibrous arrangements of the micro-crystals which were produced by the compression was seen to be divisible into four different types, the axis of the fibrous arrangement being always parallel to the direction of flow of the metal. These four different types occurred according to the initial crystallographic orientation of the specimen, depending mainly on the direction of the longer side of the specimen in reference to the crystallographic axes. In the present investigation the relation is investigated between the initial crystallographic orientation of the specimen and the type of the fibrous arrangement of the micro-crystals produced by thorough compression. [For Part III see Abstract 4077 (1931).]

AUTHOR.

2711. Effect of Direction of Drawing on the Arrangement of Micro-Crystals in Aluminium Wire and on its Tensile Strength and Fracture. T. Fujiwara. *Kyoto Coll. Sci., Mem.* 15. *pp.* 35–42, *Jan.*, 1932. *In English.*—By means of micro- and Laue-photographs the effect of the direction of drawing on the arrangement of the micro-crystals in drawn wire of aluminium was examined; and the effects on the tensile strength and on the fracture were also studied by an ordinary tensile testing machine and micro-photographs and radiographs. In the exterior part of the wire drawn always in the same direction, the micro-crystals, whose crystallographic [111] axes are inclined to the direction of the

drawing towards the exterior side and lie on a cone, were most predominant. In the wire drawn in reverse directions alternately, the micro-crystals were so arranged in the exterior part that the [111] axes were inclined to the axis of the wire on both sides, interior and exterior, and the amount of their angular displacements was less than that of the one drawn always in the same direction. In both wires the inclination of the [111] axis stated above became smaller as the core of the wire was approached, and it also became smaller with the increased reduction in diameter caused by successive drawing. The change in the arrangement of the micro-crystals was marked in the cases of 87 % to 89 % reductions in diameter and it diminished with further reduction, and in the wires reduced by about 94 % in diameter hardly any change could be recognised in the radiographs. The wire drawn in the same direction was more hardened and brittle than that drawn in reverse directions alternately, and the tensile strength and the broken fracture differed in both cases, though the difference was small in the former case. [See also Abstract 451 (1926).] AUTHOR.

2712. Behaviour of a Single Crystal of Aluminium Under Alternating Torsional Stresses while Immersed in a Slow Stream of Tap Water. H. J. Gough and D. G. Sopwith. *Roy. Soc., Proc.* 135. *pp.* 392–411, *March* 1, 1932.—This investigation was made to correlate corrosion-fatigue phenomena with the fine structure of a crystal, for which purpose X-ray, microscopical and mechanical methods have been employed and are fully described. A single crystal of aluminium was used, the corrosive agent employed being a slow-running stream of ordinary tap water. Failure by corrosion-fatigue is found to be directly related to the crystalline structure, and so is akin to failure under ordinary fatigue. The present experiment has shown that if corrosive action is superimposed on the stress effects applied in ordinary fatigue tests, these actions are mutually accelerative and failure most marked in the plastically deformed areas; a result of great importance as affording some fundamental information. The paper is replete with data, diagrams and microphotographs. H. H. Ho.

2713. Crystal Distortion Produced by Extension. V. Caglioti and G. Sachs. *Zeits. f. Physik*, 74. 9–10. *pp.* 647–654, *March* 3, 1932.—By an X-ray method the deformations of the crystal lattice are determined when (*a*) a monocrystal, and (*b*) a multicrystalline rod are permanently extended. In the monocrystal the permanent strain of the lattice is proportional to the load producing it, whereas in the multi-crystalline rod this permanent strain is not produced until a definite load is exceeded. Subsequently the distortion is proportional to the excess load above this value. The distortions are also shown to be related to the lateral contraction of the rod. The corresponding stresses residing in the lattice are of the order 10 kg./mm.^{2}, and the strain energy thus retained by the specimen about 0·004 and 0·02 kg. mm./mm.^{3} for the monocrystal and rod respectively. Only about 0·1 % of the work required by the extension is thus accounted for, whereas other experiments have shown that as much as 15 % may be used to produce internal strain. It appears therefore that most of this energy goes to produce an irregular distortion not detected by the X-ray method. J. P. A.

2714. Preparation of Single Crystals of Binary Intermetallic Compounds. C. Rossi. *Zeits. f. Physik*, 74. 9–10. *pp.* 707–710, *March* 3, 1932.—The method of Bridgman was used for the preparation

of the single crystals. Only in a very few cases was it possible to obtain an X-ray diffraction pattern of a single crystal over the whole cross-section of the specimen. F. J. W.

2715. Precision Measurement of Small Changes of Lattice Spacings of Metal Single Crystals. R. C. Hergenrother. *Physics*, 2. *pp.* 63–69, *Feb.*, 1932.—A method of studying the progressive crystal lattice changes occurring in a series of alloys or mixed crystals is described. This method compares the Bragg angles of X-ray reflection from a standard crystal with those of the crystal being studied. The important features of the method are simplicity and high accuracy (0·002 %), which is attained without the use of an accurately calibrated angle scale. The theory of the method is discussed and two examples of experimental data which have been obtained are given. AUTHOR.

2716. Precision Measurements of Lattice Dimensions. N. H. Kolkmeijer and A. L. T. Moesveld. *Phys. Zeits.* 33. *pp.* 265–269. *March* 15, 1932.—The corrections for specimen thickness in the precision measurements of lattice dimensions, which are given by Regler [see Abstract 325 (1932)], are compared with those of the authors. The agreement is very satisfactory. J. T.

2717. Lattice Theory of Ionic Crystals. M. Born and J. E. Mayer. *Zeits. f. Physik*, 75. 1–2. *pp.* 1–18, *March* 17, 1932.—A modification of the former grating theory in which the usual expression for the repulsive force between the ions is replaced by an exponential expression and in which the van der Waals cohesion force is taken into account. The following is obtained for the energy of the lattice:

$$\phi(r_0) = \alpha\epsilon^2/r_0 - C/r_0^6 + (1-k)\frac{\rho}{r_0}\left[\frac{\alpha\epsilon^2}{r_0} + \frac{6C}{r_0^6} - \frac{3VT}{N}\left(\frac{\partial P}{\partial T}\right)_V\right] + \epsilon$$

It is shown that the stability of the NaCl and CsCl types is accounted for by this energy calculation. J. E.

2718. Lattice Energy of Alkali Halides and Electron Affinity of Halogens. J. E. Mayer and L. Helmholz. *Zeits. f. Physik*, 75. 1–2. *pp.* 19–29, *March* 17, 1932.—The expression for the energy of ionic lattices [see preceding Abstract] is here used to calculate the energies of the lattices of the alkali halides. The validity of the formula is tested (1) by comparison with experimental values in the cases of CsCl and KI: (2) by obtaining the difference in heat of solution of two ions from a number of different crystals, showing that the value obtained is independent of the choice of crystals; (3) by obtaining the electron affinity of the various ions and showing that these are independent of the crystals on which the calculations are made. J. E.

2719. Orientation of Crystals of the Epsomite Series by Mica. L. Royer. *Comptes Rendus*, 194. *pp.* 1088–1090, *March* 21, 1932.—The structural analogies between mica and epsomite indicate that, when deposited on a fresh cleavage surface of mica from concentrated magnesium sulphate solution, crystals of epsomite should be orientated in a particular manner. This is verified experimentally and found to be the case also for similar deposits of goslarite and morenosite. T. H. P.

2720. Optical Properties of Mixed Crystals of Sodium-Ammonium and Sodium-Rubidium Tartrates. S. Kozik. *Acad. Polonaise Sci. et Lettres, Bull. No. 3A pp. 247–266. March 1932.* *In German.*—Replacement of a potassium atom by ammonium or rubidium in the Rochelle salt series increases the refractive index and molecular volume in the same sense. NH_4 having a slightly greater effect than Rb. In regard to face-angle, axial ratio, optic parameter, rotation and position of the optic axes, the effect of NH_4 differs from that of K or Rb. For mixed crystals of these salts the geometrical properties and the etch and weathering figures are very similar to those of the pure tartrates. Mixed crystals containing sodium ammonium tartrate show a remarkable dispersion of the optical axial plane (dispersion tourmaline), this disappearing gradually or on heating more rapidly. The refractive indices and specific rotation of the mixed crystals are additive properties. Distortion of the interference image in the neighbourhood of the exit points of the optic axes appears to indicate a certain non-homogeneity of the mixed crystals.

T. H. P.

2721. Photoelectric Coagulation of Sodium in Rock-Salt. E. Rexer. *Phys. Zeits. 33 pp. 202–204. March 1. 1932.*—Coloured rock-salt is obtained 1) by radiation with ultra-violet light (subtractive colouring) and 2) by heating in Na vapour (additive colouring). Both show the same absorption spectrum with a characteristic band at 465 $m\mu$. Radiated with blue light in this spectral region two photoelectric effects are obtained: 1) decoloration—only with subtractive colouring, 2) excitation—with both kinds. Excitation is taken to be indicated by the lowering of the absorption coefficient which occurs and which is reversed by red light. There is at the same time an increase in the absorption of the long-wave region at about 600 $m\mu$. The 465 $m\mu$ absorption is associated with Na atoms and the longer wave absorption with ultramicroscopic Na complexes. It is considered that the blue light produces photoelectric coagulation of Na atoms. [See also Abstract 2161 (1931).]

J. E.

2722. Photochemistry of Crystal-Structure Imperfections. A. Smekal. *Phys. Zeits. 33 pp. 204–206. March 1. 1932.*—These researches have been mainly on NaCl. It has been shown that the most marked differences of crystal-structure imperfections can be brought about according to the preparation, previous history and purity of the substances. Absorption associated with imperfections due either to parent ions or to added impurities occurs at the shortest wave end in the relatively near ultra-violet far from the characteristic absorption of the perfect lattice. The well known yellow coloration produced by ultra-violet light is associated with absorption by the Na-Cl parts of the imperfection locality, this absorption having its maximum at 465 $m\mu$. The same absorption spectrum is given by crystals coloured yellow by treatment with Na vapour and sudden cooling. Since Rexer has shown [see preceding Abstract] that after coagulation of the Na into ultramicroscopic particles by prolonged treatment the absorption remains the same it is obvious that the yellow coloration by ultra-violet is also due to imperfections caused by Na atoms which are therefore products of photochemical action. A second product is the neutral chlorine atom. Three possible fates of these neutral atoms are discussed. (a) Photoelectric sodium diffusion. Electrons wander to other crystal faults and there discharge Na ions producing neutral adsorbed Na atoms. (b) Photoelectric decoloration. Electrons ionise neutral

chlorine atoms. (*c*) Photoelectric excitation. Electrons discharge Na ions which have a lower ionisation potential, *e.g.*, through the influence of neighbouring foreign ions. J. E.

2723. Parachors of Germanium Compounds and the Atomic Constant for Germanium. N. V. Sidgwick and A. W. Laubengayer. *Am. Chem. Soc., J.* 54. *pp.* 948–952, *March*, 1932.—The molecular parachors of germanium tetrachloride, tetrabromide, tetraethyl and tetraethoxyl have been determined, and the average in the cases of the three former compounds gives a value 37·4 for the atomic parachor of germanium which is close to the 36 predicted by Sugden. The last-named compound gives a low value which is probably due to a structural factor, since simple alcohols give negative anomalies due to association. The values for the germanium compounds are paralleled to some extent by the corresponding silicon compounds. H. H. Ho.

2724. Atomic Parachor of Fluorine. E. C. Allen and S. Sugden. *Chem. Soc., J.* pp. 760–763, *March*, 1932.—Measurements of surface tension and density of various aromatic fluorine compounds with a view to obtaining a more accurate value for the atomic parachor of fluorine. The value now found is 25·0 as against 25·7. Methoxyboron difluoride is abnormal, being 80 % associated. A. D.

2725. Physical Properties of the Hydrides of Selenium and Tellurium. P. L. Robinson and W. E. Scott. *Chem. Soc., J. pp.* 972–979, *March*, 1932.—The surface tension of these hydrides is measured for different temperatures and the parachors deduced. The densities of the liquids are measured, more particularly to obtain data for coefficients of expansion. Comparison is made between the properties of these hydrides and others such as water, liquid ammonia and so forth. It is of interest to note that the surface tensions at the respective boiling points for hydrides of sulphur, tellurium and selenium are nearly identical (29·2 dynes/cm.), whereas that of water, largely due to dihydrol molecules, is about double, *viz.*, 59. H. M. B.

2726. Brownian Motion as the Limit of the Technique of Measurement. M. Czerny. *Ann. d. Physik*, 12. 8. *pp.* 993–1010, *March* 10, 1932.—On account of Brownian motion, a galvanometer system possesses, at room temperature, average potential energy of magnitude 2×10^{-21} watt sec. In carrying out an electrical measurement, employing the galvanometer, electrical energy is converted into potential energy, *e.g.*, into torsional energy of the suspension. In the design of such instruments, therefore, it is important that a maximum proportion η of the available energy should be converted into potential energy of the system. Values of η are calculated for the suspended coil galvanometer. The value of η for the resonance radiometer due to Hardy is found to be no greater than that of other forms of galvanometer. The value of η in the case of a thermo-element and galvanometer used to measure radiant energy is extremely small and of the order 10^{-10}. J. S. G. T.

2727. Collision Areas and Shapes of Carbon Chain Molecules in the Gaseous State: Normal-Heptane, Normal-Octane, Normal-Nonane. R. M. Melaven and E. Mack, Jr. *Am. Chem. Soc., J.* 54. *pp.* 888–904, *March*, 1932.—The viscosities of gaseous *n*-heptane, octane and nonane between 100° and 250° C. have been determined. The

calculated Sutherland constants and collision areas of the molecules are respectively: for heptane, 445 and 26·7 sq. Å.; for octane, 337 and 34·9 sq. Å.; and for nonane, 276 and 42·5 sq. Å. The relation between the Sutherland constant and boiling point is discussed, and it is shown that Vogel's empirical equation $C = 1{\cdot}47T$ could not be expected to hold for large and complicated molecules. Collision areas for the molecules calculated on the basis of a shadographic estimation of the average cross-section of probable models of ethane, propane, butane and isobutane are in fair agreement with Titani's experimental results. Similar calculations in the case of heptane, octane and nonane suggest that in the vapour phase the molecule takes the form of a loose helix. H. F. G.

2728. Collision Area of the Gaseous Carbon Tetrachloride Molecule. E. H. Sperry and E. Mack, Jr. *Am. Chem. Soc., J.* 54. *pp.* 904–907, *March*, 1932.—The viscosity of carbon tetrachloride vapour between 50° and 250° C. was determined. The Sutherland constant is 335, and the collision area 22·0 sq. Å. The domains of the chlorine atoms are approximately the same as in the chlorine molecule. H. F. G.

2729. Direct Measurement of Mean Lives of Atomic States. H. D. Koenig and A. Ellett. *Phys. Rev.* 39. *pp.* 576–584, *Feb.* 15, 1932.—A method is developed for measuring the mean lives of atomic states by means of the thermal motion of excited atoms in two forms of resonance lamps. The methods are used to determine the mean life of the cadmium 2^3P_1 state, for which state the more accurate method gives $T = 2{\cdot}5 \times 10^{-6}$ sec., with a probable error which is difficult to determine but can hardly be in excess of 10 %. Authors.

2730. Calculation of the Atomic Constants e, h, N from the Rydberg Number, the Specific Electronic Charge and the Measurements of the Short Wave-Length Limit of the X-Ray Spectrum. F. Kirchner. *Ann. d. Physik*, 13. 1. *pp.* 59–62, *March* 26, 1932.—The X-ray spectrum method as used by Duane gives $e = (4{\cdot}798 \pm 0{\cdot}006) \times 10^{-10}$, $h = (6{\cdot}615 \pm 0{\cdot}012) \times 10^{-27}$, $N = (6{\cdot}029 \pm 0{\cdot}008) \times 10^{23}$; as used by Feder it gives $e = (4{\cdot}782 \pm 0{\cdot}006) \times 10^{-10}$, $h = (6{\cdot}577 \pm 0{\cdot}012) \times 10^{-27}$, $N = (6{\cdot}049 \pm 0{\cdot}008) \times 10^{23}$. The value of e resulting from direct measurement of the charge is $(4{\cdot}770 \pm 0{\cdot}005) \times 10^{-10}$. H. N. A.

2731. Measurements of the Intensity Ratio of the Neon Isotopes Ne^{20} and Ne^{22}. L. S. Ornstein and J. A. Vreeswijk, Jr. *Zeits. f. Physik*, 75. 1–2. *pp.* 109–110, *March* 17, 1932.—The abundance ratio of the isotopes in atmospheric neon is determined from the lines 5852 ($s^1P_1 - p^3P_0$) and 6402 ($s^3P_2 - p^3D_3$). The second line is a transition from the metastable $^3D_3$ level. In both cases the ratio $Ne^{20} : Ne^{22}$ is 10 : 1, giving an atomic weight 20·18 for atmospheric neon. The respective isotope displacements for the two lines are 0·038 Å. and 0·029 Å. J. E. K.

2732. Regularities in the Structure of Isotopes. A. Carrelli. *Zeits. f. Physik*, 75. 1–2. *pp.* 111–114, *March* 17, 1932.—The isotopes of nuclei of the type $4N_\alpha + 1$, $4N_\alpha + 2$ and $4N_\alpha + 3$ can be classified in a simple manner with respect to nuclei of the type $4N_\alpha$. The only exceptions to the discovered regularities are the three light nuclei Li^6, B^{10} and N^{14}, and the radioactive nuclei Tl^{208}, Bi^{212}, Ac^{228}, Bi^{210}, Tl^{210}, Bi^{214}, Pa^{234}, U^{234} and U^{238}. J. E. K.

2733. Nuclear Moment for the Even Mercury Isotope, Hg^{198}. L. A. Sommer. *Zeits. f. Physik*, 75. 1–2. *pp.* 134–136, *March* 17, 1932.—The green mercury line 5461 is investigated with an interference apparatus of high resolving power. The observed structure is in direct contradiction with the assumption that the mercury isotope 198 has a nuclear moment $I = 1$ with a small magnetic moment. It is most probably equal to zero as in the case of the other even mercury isotopes Hg^{204}, Hg^{202} and Hg^{200}. J. E. K.

2734. Local Momentum in Wave Mechanics. Part II. L. A. Young. *Phys. Rev.* 39. *pp.* 455–457, *Feb.* 1, 1932.—It is shown that in the limit $h \to 0$ the quantity local momentum becomes equal to the classical momentum, and the equations involving local momentum become equations of classical mechanics. Operators are found for this quantity corresponding to the operator $(h/2\pi i)(d/dx)$. [For Part I see Abstract 1117 (1932).] Author.

2735. Dirac's Equation and the Spin-Spin Interactions of Two Electrons. G. Breit. *Phys. Rev.* 39. *pp.* 616–624, *Feb.* 15, 1932.—An improvement is made on a previous attempt [see Abstract 139 (1931)] to treat two particles by means of Dirac's equation. The approximate equation (1) below is considered in successive steps. The first step, following Oppenheimer, includes the electrostatic energy exactly, rather than to the first in power in e^2. This makes it possible to use it as a good starting-point in the calculation of spectral terms. The second step brings in the energy due to the interaction of the electric currents. An expression for it is given. Maxwell's equations and the conservation of energy demand the validity of the diagonal matrix elements of this expression as a first order perturbation energy, independently of theories of light quanta. The interactions of the particles with themselves give additive constants in the energy within the limits of the approximation used. Within the same limits the results are in agreement with experiment. Author.

2736. Effect of Nuclear Spin on the Radiation Excited by Electron Impact. W. G. Penney. *Nat. Acad. Sci., Proc.* 18. *pp.* 231–237, *March*, 1932.—It is shown that no theory of the polarisation of radiation excited by electron impact can be complete unless the effect of nuclear spin is taken into account. Exact expressions are developed in a few special cases and applied to the case of mercury. The anomalous behaviour of $\lambda 2537$ is shown to be due to the exaggerated importance which electron exchange has in exciting the 2^3P_1 level. An attempt is made to calculate the polarisation using first-order cross-sections, but a serious disagreement with the observed polarisation shows that the first-order cross-sections are not accurate enough for the purpose. J. E. K.

2737. Electronic Vibrational Intensities. P. M. Davidson. *Roy. Soc., Proc.* 135. *pp.* 459–472, *March* 1, 1932.—The methods of calculating electronic vibrational intensities in molecules with two nucleii are discussed. The transitions considered are those from a fixed vibrational and rotational state of the upper electronic level to a set of states in the lower electronic level differing from each other only in their vibrational quantum number. The conditions under which Morse's formula is valid are exhibited, and some new eigenfunctions are established which are useful for the graphical calculation of intensities. G. C. McV.

2738. Two-Quantum Terms for an Electron in a Diatomic Molecule. G. C. Wick. *Zeits. f. Physik*, 74. 11–12. *pp.* 773–779, *March* 11, 1932.—It is shown how to calculate the $\sigma(2s)$, $\sigma(2p)$ and $\pi(2p)$ terms for a diatomic molecule with two equal nucleii by assuming a slight alteration in the inverse square law for the motion of the electron concerned. G. C. McV.

2739. Approximate Calculation of the Lower Energy Levels of the Carbon Atom. N. F. Beardsley. *Phys. Rev.* 39. *pp.* 913–921, *March* 15, 1932.—Slater's theory of the complex atom as modified and extended by Zener and Eckart is applied to the $2p^2$ and $2p^3$ configurations of the carbon atom. The energy levels resulting from these configurations are computed. Some of the computed energy differences agree roughly with the experimental values, others indicate either that the method is not applicable or that the experimental data are not reliable. The $2p^3$, ^5S level is found to lie nearest to the normal $2p^2$, ^3P level. Of the levels for which experimental data are lacking or doubtful, the $2p^3$, ^1D is computed to lie 12·9 volts above the normal, the $2p^3$, ^3S, 13·7 volts and the $2p^3$, ^1P, 14·7 volts above the normal. AUTHOR.

2740. Quantum Mechanics of Degenerate Gas. A. Landé. *Zeits. f. Physik*, 74. 11–12. *pp.* 780–784, *March* 11, 1932.—In statistical quantum mechanics the assembly can be represented either by wave functions whose variables are the number of particles in each state or by wave-functions considered as functions of the states. It is shown that when more than one particle can occur in a given state, the two wave-equations for these two types of wave-function are not equivalent. In the case of Fermi (or of Bose) statistics, the equivalence found is due to the fortunate accident that the classical energy-equations, from which the wave-equations are derived, yield the same result. This is not so in other types of statistics. G. C. McV.

2741. Calculation of the Constants of Certain Polar Molecules by Means of Quantum Mechanics. J. G. Kirkwood. *Phys. Zeits.* 33. *pp.* 259–265, *March* 15, 1932.—The author considers a molecule of the type of the halogen hydrogen compounds, and treats it as produced by the adiabatic union of a negative ion and a proton. The reciprocal action of the ions can be regarded as compounded of the pure Coulomb force (looked on as due to an attraction between two point charges and a repulsion due to the penetration of the proton into the electron cloud of the negative ion), and an additional attraction, which is due to the polarisation of the negative ion caused by the proton. The problem may also be treated by considering the union of two neutral atoms, using the methods employed by Heitler and London, and the final results will be the same. The author uses the methods of wave mechanics and obtains expressions by means of which the equilibrium distance R_0, the dissociation energy ΔE, the electrical moment of the molecule μ, and the principal vibration frequency of the nuclei ν_0 are obtained. For HCl the values are given in the following table:

	R_0(Å.).	ΔE (volts).	$\mu \cdot 10^{18}$ *e.s.u.*	ν_0(cm.$^{-1}$).
Calculated	1·29	12·9	1·58	2700
Observed	1·27	13·7	1·03	2925

It has been found that the calculated capabilities of polarisation of the ions Cl^-, Br^- and I^- approach very nearly the capabilities of polarisation of the corresponding rare gases A, Kr and Xe. This is not the case for F^- and Ne. H. N. A.

2742. Maxwell's Equations and Eddington's Wave Equation. J. J. Placinteanu. *Comptes Rendus*, 194. *pp.* 1054–1057, *March* 21, 1932. —Assuming Eddington's form [see Abstract 343 (1932)] of the wave equation for an electron, it is shown that certain products of the wave functions and the E-matrices introduced by Eddington obey equations of the same form as Maxwell's, the independent variables, however, also being combinations of the wave functions and E-matrices. The derivation of these equations depends on the commutability relations. These products are identified with electric and magnetic forces. In the same way a relation similar to Poisson's equation for the density of electricity is deduced. The "spin" can also be interpreted in terms of the electric and magnetic forces defined in this way. G. C. McV.

2743. Densities of Mean Values in Dirac's Theory. L. de Broglie. *Comptes Rendus*, 194. *pp.* 1062–1063, *March* 21, 1932.—Using Dirac's operators, α_1, α_2, α_3 and α_4, sixteen real expressions, quadratic with respect to ψ_k, are formed. An attempt is made to interpret these quantities, which are all densities of mean values, *i.e.*, their integrals over the whole of space are mean values. One defines an invariant density of unknown significance. Four others define a quadrivector. They are the densities of the components of the world electric current. Six others include the densities of magnetic and electric moment. Of another group of four, three represent densities of spin, and the fourth is of doubtful interpretation. It may represent density of magnetism, but the author favours an interpretation in terms of spin. The sixteenth expression is of unknown significance. N. D.

2744. Continuous Atomic Matrix. W. R. Morgans. *Phil. Mag.* 13. *pp.* 664–673, *March*, 1932.—The matrices representing the capture by a nuclear charge of a kathode-ray electron travelling in a definite direction are determined. Parabolic coordinates are used. First, the Schrödinger wave equation for an electron travelling towards a nuclear charge Ze is written down. Neglecting the angular term and making certain substitutions, the solutions for the initial and final states are found. In order to evaluate the Heisenberg matrices for transitions from the initial to the final state, it is necessary to be able to integrate certain factors in the expressions for the components of the matrices, which are quoted from Schrödinger. This is done by introducing as a new variable a special function of the old variables, and by using a definite integral occurring in the theory of Bessel functions. A normalising factor is calculated separately. N. D.

2745. Foundations of Relativity. G. Giorgi. *Accad. Lincei, Atti*, 15. *pp.* 177–180, *Feb.* 7, 1932.—Recalls the fact that Reichenbach divided forces into two categories, (*a*) metric forces, which act upon bodies according to their masses, and therefore can be locally annulled—in one point-instant—by a suitable choice of reference platform; (*b*) physical forces, such as tensions and pressures of elastic bodies and electric and magnetic actions. The latter may be reduced to metric forces by suitable choice of platform for each particle. They will differ for electrons and

protons. By accepting a metric in the spacetime which is pseudo-Euclidean in the Galilean region and of Riemannian type in gravitational fields, splitting into two more complex ones in the electromagnetic fields, all the "ambiential" facts which depend on the ether-space may be accounted for. E. E. F. d'A.

2746. Complex Geometry and Relativity: Theory of the "RAC" Curvature. E. Kasner. *Nat. Acad. Sci., Proc.* 18. *pp.* 267–274, *March*, 1932.—"Rac" curvature, R, is defined as the limiting ratio of arc to chord of any curve. Ordinarily the ratio is 1; for certain types of imaginary curves, *viz.*, those with a minimal tangent line, *e.g.*, the imaginary parabola $y = ix + x^2$, R may have other values. The most important exceptional value of R is $2\sqrt{2}/3$, and in space of 3 or more dimensions the R of a regular analytic curve may have any real or complex value. The analytical geometry of R is developed. Application of the analysis to relativity theory is briefly discussed. Exceptional results of the analysis, hitherto imaginary, become real on account of the minus signs occurring in the expression for ds^2. J. S. G. T.

2747. Electromagnetism and Riemannian Geometry. C. Lanczos. *Zeits. f. Physik*, 75. 1–2. *pp.* 63–77, *March* 17, 1932.—Further developments of the author's unified field theory [see Abstract 1872 (1932)] in which the electromagnetic vector-potential enters as a result of the integration of the field-equations for an ordinary Riemannian space. An exact equation for the vector-potential is now derived. It follows that Maxwell's equations are exact in all fields. Possible connections with the equations of quantum mechanics are pointed out. G. C. McV.

2748. Relativistic Precession of Periodic Orbits in Central Force Fields. M. A. Omara. *Phil. Mag.* 13. *pp.* 722–732, *March*, 1932.—It is shown that a Newtonian periodic orbit described under central forces depending on the distance may be considered in relativistic dynamics as revolving in its own plane about the force-centre. The angular displacement corresponding to a radial libation is calculated. The case $F \propto r$ is treated fully, and the case $F \propto 1/r^2$ is briefly discussed. J. S. G. T.

2749. Non-Static Models of Universe. R. C. Tolman and M. Ward. *Phys. Rev.* 39. *pp.* 835–843, *March* 1, 1932.—If the cosmical constant is equated to zero in Einstein's gravitational equations, then it follows that any spherical universe in which the pressure is not negative must increase to a maximum volume in a finite time, if started from some finite volume with a finite rate of expansion. It must then collapse to zero volume, also in a finite time. It is assumed that the universe then begins to expand again, although the mathematical analysis does not proceed through the point of zero volume. The question of what happens to the matter in the universe when the volume is zero is not dealt with. G. C. McV.

2750. Solutions of Cosmological Field Equations and Models of Universe with Annihilation of Matter. S. Kunii. *Kyoto Coll. Sci., Mem.* 15. *pp.* 97–111, *March*, 1932. *In English.*—A discussion of the various types of solutions of Einstein's equations applicable to expanding or contracting universes. G. C. McV.

METEOROLOGY, GEOPHYSICS AND ASTROPHYSICS.

2751. Evaporation from Lakes and Reservoirs. C. E. Grunsky. *Monthly Weather Rev.* 60. *pp.* 2–6; *Disc.*, 6, *Jan.*, 1932.—Reasons are given for the view that records of evaporation obtained by Fitzgerald and Bigelow are unreliable. The evaporation pans used at present in U.S.A. are stated to give faulty results because of the effects of insolation and wind on the sides and rim of the pan. The author suggests a new type of evaporation pan, with the rim projecting above the natural surface of the ground, but the earth banked up nearly to the top while the inner rim has a V-shaped lip. Observations should be made of the air and water temperatures, rainfall and wind velocity. Curves and a table illustrate the method of correcting for wind, pressure (and thence altitude) and mean monthly air temperature. It is considered this method will give more satisfactory comparisons of evaporation loss from widely separated large open-water surfaces. In the *Discussion*, **C. F. Marvin** explains the reasons for adopting the present form of evaporation pan, and considers that while the results from it may have a limited application for exact evaporation it has a greater value for other purposes. R. S. R.

2752. Rational Theory of the Cup Anemometer. C. F. Marvin. *Monthly Weather Rev.* 60. *pp.* 43–56, *Feb.*, 1932.—The author reviews first the 1888 tests of the standard Weather Bureau anemometer to get the true (W) from the indicated (V) wind velocities for measured values up to 50 m.p.h. and estimates up to 100 m.p.h., the latter being given by the equation $\log W = 0{\cdot}509 + 0{\cdot}9012\,V/3$. The new series of tests confirms the general high accuracy of the old tests, but the range is now extended up to 140 m.p.h. These lead to a new equation of the form $V = (b'W^2 - f'W)/(W + a')$, where b' is the principal constant and depends upon the number, form and diameter of the cups, length of arms, friction, etc., f' is a special friction constant depending upon friction at very low velocities, and a' is a small constant depending upon one of the asymptotes, such that $W = -a'$ for $V = \infty$. A theoretical survey of the whole problem is made, and in tables and diagrams are shown the results of the new test observations and their analysis. The values a', b' and f' are discussed in detail. It is concluded that the old 4-cup type is decidedly superior for accurate and dependable measurement of wind velocity, especially of hurricane force, but the mechanical construction must be improved, while relatively compact cup wheels are wholly unfit as standards. As a result of the tests the Washington Weather Bureau has restored the old 4-cup standard for official use from Jan. 1, 1932, after using the 3-cup standard for a few years. R. S. R.

2753. Meteorological Cycles. F. Gun. *Ann. Soc. Sci. de Bruxelles*, 52. *pp.* 20–27, *March*, 1932.—A demonstration of the existence of meteorological cycles is given. They are divided into four families which have their origin in different parts of the earth's surface. They can be used to predict the weather a long time in advance, and to foretell to a day the appearance of cyclones or anticyclones. H. M. B.

2754. Energy Due to the Distribution of Pressure in a Typhoon Area. Y. Horiguti. *Imp. Marine Obs., Kobe, Japan, Mem.* 5. *pp.* 1–10, *March*, 1932. *In English.*—Assuming a definite mass and volume and

no external forces, Margules calculated the potential energy due to the pressure distribution in a cyclonic area and found it too small to balance the kinetic energy of the winds. The author considers cases where external energy is brought into the system, and the stored energy is compared with the kinetic energy. This storage of energy is obtained for isothermal and adiabatic changes under different circumstances. The volume integral of the stored energy, or the potential energy, due to the pressure distribution for isothermal and adiabatic changes is calculated. The kinetic energy depends on the pressure gradient, latitude, resistance and radius of curvature of the path. Among mechanisms considered for the formation of the pressure distribution the mode of central heating and the transference of air from outside probably act together in such tropical storms as typhoons, and are of importance for the maintenance of the energy. If there is another source of energy, such as discontinuity of temperature, the typhoon will increase in intensity. It is concluded that the stored energy in the distribution of pressure corresponds to the kinetic energy in the cyclonic system, and it is necessary to import the energy into the system from outside. R.S.R.

2755. Ice Formation and Related Problems in Hydrology. M. Bossolasco. *Con. Naz. Italiano, Geod. e. Geofis., Boll.* 2. *pp.* 28–30, *Feb., and pp.* 41–50, *March,* 1932.—A discussion of the various theories put forward to account for the formation of ice on the sea, lakes and rivers, and the rate at which it penetrates into humid earth. It has been shown that the depth of penetration is proportional to the square root of the time taken, but the constant obtained theoretically does not agree with that found by examination of Arctic ice-floes during English expeditions from 1829 to 1853. Devik introduces into his theory the meteorological conditions of the air above the ice, and obtains an equation giving curves between depth and time which cut those of the earlier theory after a few days, or even hours, and then diverge from them considerably. H. M. B.

2756. Development in Series of the Gravity on the Surface of the Ellipsoid of Rotation. M. Boriosi. *Con. Naz. Italiano, Geod. e. Geofis., Boll.* 2. *pp.* 1–6, *Jan.,* 1932.—The coefficients of the series with which Somigliana represents gravity at the surface of the ellipsoid are expressed as functions of the constants α and β, used by Cassinis [see Abstracts 562 (1928) and 762 (1931)]. Then each coefficient of the function $C(i)$ of Clairaut defined by Somigliana and of $\chi(\alpha)$ introduced by Cassinis is calculated. The function $\chi(\alpha)$ is found to be more rapidly convergent than $C(i)$, so fewer terms of the series are necessary to give an accurate value of gravity. H. M. B.

2757. Tidal Oscillations in a Rectangular Basin of Variable Depth. K. Hidaka. *Imp. Marine Obs., Kobe, Japan, Mem.* 5. *pp.* 15–23, *March,* 1932. *In English.*—In the mathematical treatment given, the author assumes a law of depth $h = h_0(1 - x^2/a^2)$, where h_0 is the maximum depth all over the basin and found along the straight line $x = 0$. The various types of oscillations found are discussed. In an example of the results for a square basin it was found that for some modes the variation of depth increases the length of the period of oscillation, but for others the effect is reversed. R. S. R.

2758. Seiches of a Frozen Lake: Movements of the Ice-Sheet. M. Mukai. *Phys. Math. Soc., Japan, Proc.* 14. *pp.* 108–111, *March,* 1932. *In English.*—The seiches of Lake Suwa (Nagano) determined from the

movements of a water surface kept clear of ice are quite similar to those of the unfrozen lake [see Abstract 191 (1911)], and synchronise accurately with movements of the ice-sheet covering the lake. C. A. S.

2759. Dynamic Theory of the Tides. M. Brillouin. *Comptes Rendus*, 194. *pp.* 801–804, *March* 7, 1932.—In the development of the dynamic theory of tides, according to the hypothesis of Laplace, difficulties have occurred in completing the calculations at certain critical latitudes. A re-examination of the theory shows that these difficulties are really illusory. W. A. R.

2760. Electrical Prospecting in Oil-Fields. L. J. Peters and J. Bardeen. *Physics*, 2. *pp.* 103–122, *March*, 1932.—The fundamental theories for the use of either d.c. or a.c. are worked out. The methods are illustrated by reference to actual surveys. In using a.c., low frequencies give the best results, and in investigating greater and greater depths the frequencies must be continually lowered. These methods have up to the present time not yielded information of value in oil geology below a depth of 2000 feet. W. A. R.

2761. Correlation of Isogeothermal Surfaces with Rock Strata. C. E. van Orstrand. *Physics*, 2. *pp.* 139–153, *March*, 1932.—An instance of regional variation and two cases of local variation were selected for consideration from a large number of geothermal surveys. The causes of local and regional variations are unknown. Possible explanations such as radioactivity, proximity to crystalline rocks, and transfer of heat along the strata are given careful consideration in attempting to explain the observed relations between the strata and the isogeothermal surfaces. AUTHOR.

2762. Geothermal Gradient Determinations in the Lake Superior Copper Mines. L. R. Ingersoll. *Physics*, 2. *pp.* 154–159, *March*, 1932. —Temperatures were measured with mercury thermometers mounted in bakelite tubes, placed in drill holes in mine workings where the rock had been freshly exposed, special attention being given to the effects of drilling, blasting and other heat conduction considerations. Results gave as the average gradient from the surface to 5679 feet below (temp. 95·3° F.), 1° F. in 108·5 ft. (0·0168° C./m.). The gradient is more nearly uniform than has sometimes been supposed. A preliminary attempt was made at calculating the previous "thermal history" of this region. Diffusivity of specimens of the rock measured 0·0075 c.g.s. units, and on this basis calculations of theoretical temperature-depth curves were made for twenty-five different assumptions of previous temperature conditions, and compared with the actual curve. Results were inconclusive, but indicate that at least 30,000 years have elapsed since the last glacial epoch, a longer period than usually assumed. AUTHOR.

2763. Velocity of Elastic Waves in Granite. L. D. Leet and W. M. Ewing. *Physics*, 2. *pp.* 160–173, *March*, 1932.—The velocity of elastic waves in granites, d 2·65—all very similar—determined over distances of 50–4600 ft., averaged for longitudinal waves $5{\cdot}04 \pm 0{\cdot}03$, and for transverse waves $2{\cdot}48 \pm 0{\cdot}03$ km./sec. Deduced from these results the bulk modulus is $(44 \pm 1) \times 10^{10}$, compressibility $(2{\cdot}28 \pm 0{\cdot}05) \times 10^{-12}$, rigidity $(16{\cdot}3 \pm 0{\cdot}4) \times 10^{10}$, Poisson's ratio $(0{\cdot}333 \pm 0{\cdot}005)$ and Young's modulus $(43 \pm 1) \times 10^{10}$, all in c.g.s. units. The

form of the time/distance curves shows that the waves do not penetrate deeply. Adams and Williamson's compressibility/pressure curve is incorrect for pressures < 2000 megabars. [See Abstract 1341 (1923)]. C. A. S.

2764. Asymmetry of Sound Velocity in Stratified Formations. B. McCollum and F. A. Snell. *Physics*, 2. *pp.* 174–185, *March*, 1932. —In the course of explorations of subsurface geology by the seismograph the authors have frequently observed the pronounced effect of stratification on the velocity of seismic waves in shales, and this effect has often been utilised in practical seismography. Recently an opportunity was afforded for securing additional quantitative data on the velocity normal to and parallel to the bedding planes. The paper points out that the velocity parallel to the planes of stratification is, in some instances, as much as 50 % higher than the velocity in a direction normal to the bedding planes. It is shown also that inclined stratified beds exhibit a higher apparent point-to-point velocity when sound travels in an up-dip direction than when travelling down-dip. The paper describes a procedure whereby this effect may be utilised for determining the direction and approximate magnitude of the dip in such stratified deposits. The method has proved to be of considerable practical importance where the stratified formations are obscured by overlying deposits. AUTHORS.

2765. Calculation of Ground Motion from Seismograms. H. A. Wilson. *Physics*, 2. *pp.* 186–199, *March*, 1932.—The equation of motion of a mechanical seismograph is $-\ddot{x} = \ddot{y} + 2k\dot{y} + p^2y$, where x is the ground displacement and y the seismograph deflection. This equation may be solved for y when x is supposed known, or for x when y has been observed as a function of the time. In this paper both of these ways of solving the equation are considered. The motion of the seismograph due to a train of waves starting at $t = 0$ is considered, and also the motion due to the arrival of a single wave. In each case seismographs with several periodic times and either undamped or critically damped are considered. Curves are given showing the motion of the ground and the calculated motion of the seismograph. The motion of the ground corresponding to several simple assumed seismograms is also worked out and shown by means of curves. The motion corresponding to a given seismogram depends greatly on the periodic time and damping of the seismograph. Finally, the ground motion is deduced from two actual seismograms due to dynamite explosions. An integraph is described which enables the calculations to be done more quickly. AUTHOR.

2766. Free Oscillations of Strata Excited by Seismic Waves. K. Sezawa and K. Kanai. *Tokyo Univ. Earthquake Research Inst., Bull.* 10. *pp.* 1–18, *March*, 1932. *In English.*—The work of an earlier paper [see Abstract 388 (1931)] is continued. It is now found that resonant phenomena following on a train of harmonic waves are only likely to occur in an isolated body. Free vibrations of strata cannot be excited by harmonic waves of infinite extent, but they may be excited by arbitrary waves or by harmonic waves of finite extent, provided that the excited vibrations are damped out relatively quickly. W. A. R.

2767. Waves in Visco-Elastic Solid Bodies. K. Sezawa. *Tokyo Univ. Earthquake Research Inst., Bull.* 10. *pp.* 19–22, *March*, 1932. *In English.*—A reply to criticism of an earlier paper by the author [see Abstract 855 (1928)] on the decay of waves in a visco-elastic body. W. A. R.

2768. Propagation of Seismic Waves. Part I. H. Kawasumi. *Tokyo Univ. Earthquake Research Inst., Bull.* 10. *pp.* 94–129, *March*, 1932. *In English.*—From seismographic observations of the Tiba earthquake of 21/5/28 at thirty-nine stations, and assuming that the crust consists of two layers of thicknesses 20 and 30 km., the ultra-basic layer beginning at 50 km., the velocity of P waves at the boundary of this layer is 7·41 km./sec., or, generally, where r is the distance to the centre of the earth $0{\cdot}003509r - 0{\cdot}002337r^2$. The ratio of this velocity to that of S waves is 1·738, or very nearly $\sqrt{3}$, giving a velocity of the S waves of 4·26 km./sec., and making the Poisson ratio 1/4 to a probable depth of 1200 km. Very similar results are deduced from the travel-time curves of 85 long-distance earthquakes. Tables showing travel-time of P waves in the ultra-basic layer and time-distance curves for various depths of focus are given. C. A. S.

2769. Propagation of Seismic Waves. L. Cagniard. *Comptes Rendus*, 194. *pp.* 899–902, *March* 7, 1932.—Lamb studied the surface propagation of an earthquake which originated at a point on the surface. The author derives expressions for waves originating below the surface and propagated within the crust. W. A. R.

2770. Reflection at the Surface of the Ground of a Spherical Isotropic Seismic Wave. L. Cagniard. *Comptes Rendus*, 194. *pp.* 1005–1008, *March* 14, 1932.—The author obtains mathematically a function for the reflected wave. Under certain specified circumstances a superficial phenomenon results for which one kind of speed of propagation can be defined equal to that for Rayleigh waves, but it cannot be effectively dissociated from the reflected wave of distortion. R. S. R.

2771. Portable Horizontal-Pendulum Seismometer. F. Kishinouye. *Tokyo Univ. Earthquake Research Inst., Bull.* 10. *pp.* 188–191, *March*, 1932. *In English.*—The instrument consists of an aluminium drum carrying smoked paper, 25·5 cm. long and 18 cm. dia., rotating once in 10 min., with two horizontal pendulums, each with a cylindrical lead bob weighing 5 kg. The whole is packed in two boxes, weighing 18·5 and 17 kg., maximum length 54 cm. It works well for a period of 3·5–5 sec., with magnification 40, and has been used to record the after shocks of several earthquakes. A synchronous motor is described for use if electric power is available. C. A. S.

2772. Pressures in Earth Masses. E. Callandreau. *Comptes Rendus*, 194. *pp.* 953–955, *March* 14, 1932.—According to Boussinesq's theory of pressures in pulverulent masses [see Abstract 852 (1917)] the lines and surfaces of slip are in general curved. In Coulomb's theory of the rupture of homogeneous prismatic masses the lines of rupture are, however, straight. The author traces a formal correspondence between the two theories, and concludes that in practice no great difference may be expected between their results. J. P. A.

2773. Effect of Surface Loading. G. Nishimura. *Tokyo Univ. Earthquake Research Inst., Bull.* 10. *pp.* 23–28, *March*, 1932. *In English.*—The deformation of a semi-elastic body of indefinite extent due to surface loading is worked out. A surface layer overlying the body is postulated. If the body is more rigid than the surface layer, the displacement normal

to the surface is small. If the surface layer is more rigid than the body the surface displacement is large. W. A. R.

2774. Swarm Earthquakes. T. Terada. *Tokyo Univ. Earthquake Research Inst., Bull.* 10. *pp.* 29–35, *March,* 1932. *In English.*—It has been noticed that earthquakes sometimes occur in swarms. Swarms of long as well as of short duration have been detected. Their statistical distribution is found to be of a definite type resembling other natural phenomena, for example, the number of flowers of certain types which fall in a day. A swarm earthquake may be the result of a group of " latent " origins of earthquakes which are gradually ripening, or approaching a critical state. The time of attaining such state is distributed about the mean value according to some statistical law. Moreover, it may be supposed that each quake has an influence upon the whole group of latent sources. Such a hypothetical case is capable of giving a distribution similar to that of the actual swarm. W. A. R.

2775. Earthquake Frequencies. S. Yamaguti. *Tokyo Univ. Earthquake Research Inst., Bull.* 10. *pp.* 36–42, *March,* 1932. *In English.* —The relation between the annual seismic frequencies in Japan and those in other parts of the world is studied. There is some trace of positive correlation between the seismic frequencies of Japan and South America. There is also some probable correlation between South America and the Philippines. China and Japan appear to be in negative correlation, so that when earthquakes are decreasing in China they are increasing in Japan. There are scarcely any definite relations between the earthquakes in the land area and those in the sea bed near the district of Kwantó. For other regions of the world no relations are detected. W. A. R.

2776. Barometric Gradients and Earthquakes. W. Inouye and K. Hasegawa. *Tokyo Univ. Earthquake Research Inst., Bull.* 10. *pp.* 55–82, *March,* 1932. *In English.*—The barometric gradients at the time of earthquakes in Japan during the fourteen years beginning in 1912 were examined. In most cases the barometric gradients at earthquake epochs were directed to two narrow sectors opposite to each other. The effects suggest that there are tectonic lines having directions peculiar to each district, and that the barometric gradient acts as a trigger. The after shocks of the great Formosa earthquake, Sept. 2, 1922, occurred when the barometric gradients had been directed just opposite to that at the time of the main earthquake. The great Kwantó earthquake, Sept. 1, 1923, changed the azimuthal distributions of the barometric gradients at the earthquake epochs in several districts. W. A. R.

2777. Analysis of Z Terms for the International Latitude in the North Parallel for Washington and Greenwich. H. Kimura. *Imp. Acad. Tokyo, Proc.* 8. *pp.* 74–77, *March,* 1932.—For the international latitude values observations are used for the same three stations, Mizusawa, Carloforte and Ukiah, and expressions are set out for the two series 1900–11 and 1922–30. For the Washington observations a mercury basin and photographic plate were used instead of the usual zenith telescope, while for the Greenwich observations a Cookson floating zenith telescope was used with a photographic method. The values of Z, tabulated in each case, are simple means of residuals in the sense of Washington (or Greenwich) —international for each tenth-year of the eight years, 1923–30, and a comparison is made of the observed and computed values. The computed

values are deduced graphically from the calculated values for the mean epoch of each group combination. R. S. R.

2778. Bright Meteor Passing the Pleiades. W. J. S. Lockyer. *Roy. Astron. Soc., M.N.* 92. *pp.* 449–451, *March,* 1932.—On the night of January 11th a Zeiss triplet camera was exposed to the region of the Pleiades from $21^h \cdot 40^m$ U.T. and at $23^h \cdot 10^m$ another Zeiss triplet camera was exposed to the same region, both being closed at $2^h \cdot 40^m$ U.T. On development both plates showed a meteor trail which entered at one end of the plates and faded out before reaching the other, the greatest luminosity being nearest the Pleiades. A photograph is given. The radiant point lies on a line passing through Perseus near the boundary between Cassiopeia and Camelopardalus, and through Cepheus and Draco. No visual observations have come to hand. The nucleus of the meteor is distinctly visible throughout that portion of the trail where volatilisation was greatest, unlike the 1922 meteor [see Abstract 1071 (1923)], indicating that the hot vapours from the nucleus were less luminous than the nucleus itself. The 1922 meteor was brighter and probably moved more slowly. A. S. D. M.

2779. Temperature of a Meteorite in Neighbourhood of the Sun. T. Araki and R. Yamamura. *Kyoto Coll. Sci., Mem.* 15. *pp.* 113–122, *March,* 1932. *In French.*—A calculation is given of the temperature to which a comet (considered as a swarm of meteorites) will rise as it approaches the sun, for the various types of orbit possible under the inverse square law. G. C. McV.

2780. Formation of Magnesium b Lines in the Solar Atmosphere. G. G. Wiles. *Roy. Astron. Soc., M.N.* 92. *pp.* 401–407, *March,* 1932.—Plaskett has shown [see Abstract 4127 (1931)] that a model atmosphere of combined absorption and scattering is consistent with the observed line contours in the solar spectrum. A modification of his method of calculation is found necessary on physical grounds, and a somewhat different procedure is accordingly adopted. The model of combined absorption and scattering is still found to be satisfactory, but the ratios of the various absorption and scattering coefficients are found to vary with wave-length through the line in a less unexpected way. It is no longer possible to conclude that the atomic life of an excited atom varies with wave-length through a line. J. E. K.

2781. Diamagnetism and Drift Currents in the Solar Atmosphere. T. G. Cowling. *Roy. Astron. Soc., M.N.* 92. *pp.* 407–413, *March,* 1932.—For electrons in the atmosphere of the sun it is shown that in the transition layer where the electrons are beginning to be free to spiral under the action of the sun's magnetic field, there are drift currents similar to those which mask the diamagnetic effect of spiralling in a metal. These currents completely mask the diamagnetic effect in the gas, in spite of the fact that the thickness of the transition layer is many times the radius of spiralling. The theory leads to the rejection of Gunn's discussion of these effects. G. C. McV.

2782. Radial Velocities of 523 O and B Type Stars Obtained at Victoria, 1923–1929. J. S. Plaskett and J. A. Pearce. *Dominion Astrophys. Obs. Victoria, Publ.* 5. 1. *pp.* 1–98, 1931.

2783. Catalogue of Radial Velocities of O and B Type Stars. J. S. Plaskett and J. A. Pearce. *Dominion Astrophys. Obs. Victoria, Publ.* 5. 2. *pp.* 99–165, 1931.

2784. Improvement of Elliptic Orbits. T. Banachiewicz. *Bull. Astronomique,* 7. 1. *pp.* 1–11, 1931.—Follows up the author's previous papers on the application of cracovian matrices to orbit computation with a comparison of these "new type" formulæ with van den Bos' arithmetical method. The author recommends the use of the unknowns $d\mathbf{p}$, etc., giving the components of rotation of the orbit, instead of the usual variations of elements. He shows that his method involves fewer symbols than the other, and also fewer numerical operations. In an independent section papers by Popovici and Jekhowsky are discussed, in which corrections to more than one element are obtained from a single observation; general forms are obtained in the new notation, showing difficulty in separating any one element besides M, and error in supposing that complete corrections can be deduced. T. L. M.

2785. Visual Binary Orbits, and Application to Sirius. C. Volet. *Bull. Astronomique,* 7. 1. *pp.* 13–31, 1931.—The author discusses the unsatisfactory relation of such methods as Kowalsky's to the theory of errors. He introduces a reduction of each observation from angle and distance to rectangular co-ordinates, and writes equations in seven parameters related to the normal orbital elements, but suitable for least-squares treatment. First approximations to the unknowns must be obtained, as accurately as possible, since this saves subsequent labour; using these, a system of normal equations is written. The method is applied to the orbit of the companion of Sirius. The orbit obtained is in very good agreement with that of Aitken (1918). T. L. M.

2786. Contours of Narrow Absorption Lines. A. Unsöld. *Astrophys. J.* 75. *pp.* 106–114, *March,* 1932.—A simple approximate method for calculating the widening of spectral lines by a grating spectrograph is developed. It is shown that the deviations from theory found recently by R. v. d. R. Woolley [see Abstract 2617 (1931)] in observations of atmospheric oxygen lines are due to this instrumental effect. Woolley's measures of contours of solar lines are affected by the same systematic error. It is shown that in the range of line-widths, where Doppler effect comes into play, the actual line-contours cannot be fully resolved with a grating of the usual size. Following Minnaert and Mulders, the limitations of the Russell-Adams calibration are discussed. The exchange of radiation in solar lines is considered. It is shown that in the case of penultimate lines interlocking does not make quantitative spectral analysis impossible. Interlocking may give a mechanism for producing central intensity, which avoids the difficulties of the collision theory. Reply by **R. v. d. R. Woolley,** *Observatory,* 55. pp. 142–145, May, 1932. AUTHOR.

2787. Distribution of Absolute Magnitudes among Stars Brighter than the Sixth Apparent Magnitude. G. Strömberg. *Mt. Wilson Observat. Contrib. No.* 442. *Astrophys, J.* 75. *pp.* 115–126, *March,* 1932.—Summary and discussion of previous work [see Abstract 1155 (1932)]. The distribution curves for the various spectral classes are reproduced, all reduced to equal numbers of stars. They are also recalculated in terms of bolometric absolute magnitude. Comparison of different

spectral classes indicates the possible presence of three other chains, in addition to the main sequence and the normal giants, running through a large range of types; in several instances, however, the number of stars involved is small, and the result is to be accepted with caution. In addition to the well-known gap between giants and dwarfs among late stars there is, however, at least a gap between normal giants and brighter stars, which runs with considerable consistency from about B3 to G8. The observational selection introduced by the limitation in apparent magnitude is not corrected for. Its effect is small in groups of small dispersion. R. d'E. A.

2788. Spectroscopic Observations of SX Herculis. A. H. Joy. *Mt. Wilson Observat. Contrib. No.* 443. *Astrophys. J.* 75. *pp.* 127–132, *March,* 1932.—The star seems intermediate between Cepheids and long-period variables. General spectrum that of a G giant; absolute magnitude at maximum — 1·5; period 103 days. The *c*-characteristics are not as marked as in Cepheids of the same spectral type. The hydrogen lines appear in emission, except quite close to the minimum. Velocity-curves obtained from emission and absorption run very differently; the absorption curve is advanced with respect to the brightness curve by about 1/5 period, and the emission velocities have their maximum when the absorption ones have their minimum. Near the minimum TiO bands appear, although the temperature seems much too high for them; the classification indicated by the bands is regularly about 1·3 classes later than that obtained otherwise. The strength of emission lines is different at different maxima, but is greatest when the type is earliest. R. d'E. A.

2789. Spectrum of the Iron Star XX Ophiuchi. P. W. Merrill. *Mt. Wilson Observat. Contrib. No.* 444. *Astrophys. J.* 75. *pp.* 133–146, *March,* 1932.—The light-variation is of the R Corona type. The light-curve since 1919, as determined at Harvard, is shown. The spectrum is of class Bep. Between 1921 and 1931 it passed through a remarkable cycle of variation. At the beginning and end of this period it was marked by emission lines of H and FeII, but in 1925 wide, displaced absorption lines appeared, among which lines of TiII were prominent. Estimated intensities of bright and dark lines of H, FeII and TiII are given. The behaviour of lines of CrII, ScII, MgII, Al III and HeI is described. The bright metallic lines (FeII, [FeII], TiII, CrII, ScII, MgII and Al III) give displacements which agree within observational errors, but the mean displacement of H lines is algebraically greater by about 30 km./sec. Widths of dark lines were about 6·Å. in 1925, but decreased thereafter. The relative displacements of dark components with respect to the bright lines are shown. On the accompanying plate the narrow dark components do not adjoin the bright lines, but are displaced towards the violet. *Discussion.*—At the beginning and end of the period of observation certain lines were strongest, particularly H em and FeII em, while in 1925 the following were strongest: H abs, FeII abs., Ti em and abs., Cr em and abs., Sc em and abs. The behaviour of a close pair of FeII lines suggests that the absorbing stratum overlay that in which the emission occurred. The positions of the bright lines are nearly independent of the intensities and positions of the dark lines. The great change in spectrum during a period of constant brightness is puzzling. Comparing this star with Novæ, we may use Halm's expanding-shell hypothesis to explain some of the differences between them by a difference in the relative radii of shell and stellar surface. AUTHOR.

2790. Spectrophotometric Study of Y Ophiuchi. C. J. Krieger. *Astrophys. J.* 75. *pp.* 147–157, *March*, 1932.—The investigation is based on 19 spectrograms obtained at the Lick Observatory in 1929. Moll microphotometer tracings of all plates were made. The spectral type is found to vary between F5 and G3. The corresponding temperature change, considering Y Ophiuchi as a normal giant, is from 5000° to 6400° K. The intensity distribution of the continuous background derived by Yü's method, with ζ Ophiuchi as a comparison star, gives a black-body temperature variation from 3500° to 5400°. Mendenhall's method, using B4618 and B4660 as comparison stars, furnishes a temperature variation from 3300° to 5800°. The variation based on colour indices is from 3700° to 5700°. The mean variation of the effective surface temperature is from 3600° to 5600°, with a probable error of an individual determination of $\pm$ 200°. The magnitude curves at $\lambda\lambda$ 4200, 4500 and 4800 are derived. The probable error of an individual determination is $\pm$ 0^m·12. The strengths of the β, γ and δ lines of hydrogen, the H and K lines, and the G band are found in terms of the intensity of the continuous background. AUTHOR.

2791. 27 Canis Majoris. O. Struve. *Astrophys. J.* 75. *pp.* 158–160, *March*, 1932.—The hypothesis advanced by McLaughlin (see Abstract 1917 (1932)] is discussed. The helium lines show no visible emission and the star is altogether different from normal Be's. The displacements of the absorption lines are probably real, and are caused by Doppler effect. It is possible that the lines are not produced in the reversing layer, but in an extended shell of gas not directly connected with the star. The possibility that the changes in radial velocity are not caused by orbital motion has been emphasised in previous papers, but a decision must be postponed until more observations are available. AUTHOR.

2792. Stellar Coefficients of Absorption and Opacity. Part II. S. Chandrasekhar. *Roy. Soc., Proc.* 135. *pp.* 472–490, *March* 1, 1932. —A more rigorous calculation than has hitherto been attempted is given of the absorption due to " bound-free " transitions from the K and L states for atoms on a perfect gas. The total absorption coefficient is then calculated for hydrogen-like atoms and is found to be proportional to $\rho/T^{9/2}$ for temperatures $< 10^5$ ° C. The new method of averaging employed and the greater accuracy in the value of K and L absorption both lead to the conclusion that the importance of bound-free absorption has been exaggerated in previous work in comparison with free-free absorption. A formula for the total absorption of all types of atoms is derived, and the mass absorption coefficients for various elements under stellar conditions are evaluated numerically. The values are still smaller than those obtained by previous workers, and the discrepancy between the " physical " and the " astronomical " absorption coefficient is thus increased. Doubts are expressed as to the reliability of the absorption law, $\rho/T^{7/2}$, for a perfect gas; it appears to hold only at very high temperatures. G. C. McV.

2793. " Guillotine Factor " in Stellar Opacity. A. S. Eddington. *Roy. Astron. Soc., M.N.* 92. *pp.* 364–368, *March*, 1932.—In Kramers' formula for the coefficient of opacity the " guillotine factor " g reduces the opacity calculated for dwarf stars. The present paper improves on the rough calculations given so far, on the assumption of a mixture of elements —for a pure element has much lower opacity. A general formula is ob-

tained and a table of values given. A short *Addendum* deals with the inclusion in g of the correction for stimulated emission (saturation effect), which is not large. T. L. M.

2794. Interpretation of Early-Type Spectra. Cecilia H. Payne. *Roy. Astron. Soc., M.N.* 92. *pp.* 368–388, *March*, 1932.—The first part of the paper deals with absorption lines observed in B and O type stars. The identifications are nearly complete, and are shown by a series of Grotrian diagrams to include all lines possible in the range of wave-length studied except a few inter-system combinations, etc. The star-type, for which each spectrum is at maximum intensity, is found to be closely associated with the ionisation potential of the corresponding atom. The ionisation and therefore the temperature increases the earlier the spectral class; the colour temperatures do not keep pace with this; the problem is discussed, and the author concludes that the definition of temperature is responsible for the difficulty. The second part of the paper deals with the bright lines in B and O stars. General conditions for the production of bright lines are set down; it is shown that Rosseland's interpretation still provides a satisfactory representation of the processes involved; a number of typical bright-line stars are analysed in detail; and it is concluded that the bright-line spectra of all can be pictured in terms of fluorescence. Certain difficulties are shown to remain, especially with reference to the observed intensities. T. L. M.

2795. Peculiarities in Type B Stellar Spectra. D. L. Edwards. *Roy. Astron. Soc., M.N.* 92. *pp.* 389–394, *March*, 1932.—Certain B stars do not agree with the Harvard system for a particular star, owing to the abnormal behaviour of one or more lines, and these may be arranged in five somewhat vague groups. I shows the He lines strong enough to place them types B5–B9, but from the behaviour of the [K] line of Ca^+ they should belong to A_0 or A_2; Fe^+, Ti^+ and Sr^+ are weak or absent. II is like I, but shows strong typical A_2 lines giving the effect of a complete spectrum (A_2 superposed on B8, which may actually be the case). III also gives the He lines as in B8 or B9; sometimes Fe^+, Si^+ and Sr^+ as in A_0 and A_2, but the [K] line faint or absent. IV shows O^+ lines increasing in intensity from types B3 to B0; O^+ appears abnormally strong for the spectral type. V gives inconsistent classifications where the Norman Lockyer observation differs by more than one step of the Harvard sequence from the Henry Draper catalogue. These may be due to an observational error in the classification, or to some peculiarity in the spectrum, or to an actual change in the spectral type. An outstanding example of this is ψ Eridani, classed as B8 at Harvard, but possessing He lines as strong as in B2, and thus given a class of B3 at the Norman Lockyer Observatory. It is unlikely that a mistake has been made in classifying a star as bright as magnitude 4·8. A. S. D. M.

2796. Stellar Hydrogen Lines and their Variation with Temperature and Surface Gravity. E. G. Williams. *Roy. Astron. Soc., M.N.* 92. *pp.* 394–396, *March*, 1932.—The results are based on 162 slit spectra of 82 stars (types O–M), for which some measurement of effective temperature, Te, has been made. Hγ is observed in all stars; Hβ and Hδ in 56 and 52 respectively. Mean absorption ratios are found for different spectrum ranges by weighting each pair of lines observed in any one spectrum according to their quality thus, Hβ: Hγ and Hδ: Hγ for ranges

O–B5, B8–A, F, G–M and all stars, enabling Hγ and Hδ to be used to obtain a mean absorption for Hγ of increased weight for stars in which these lines have been observed. A plot of this against Te shows a pronounced maximum for dwarfs at a temperature between 10,500° (A5) and 12,500° (A0), where there is a large negative absolute magnitude effect such that a star with surface gravity twenty times that of another has five times the H absorption. This vanishes for F and becomes positive for later types, thus disagreeing with Milne and Pannekoek; the inclusion of the intermolecular Stark effect (ignored by these two authors) is not sufficient to harmonise the theories. A pronounced statistical correlation is found between Te and line depth, and this again is in disagreement with the above theories. Late type giants seem to have deeper H lines than late type dwarfs; this is perhaps masked by axial rotation in hot stars. Early type H lines have exponential contour form; late type H lines appear broader relatively near the centre and narrower in the wings. A. S. D. M.

2797. Intensity Distribution in Emission Bands of Novæ. J. Genard. *Roy. Astron. Soc., M.N.* 92. *pp.* 396–400, *March,* 1932.—A correct hypothesis of Nova emission bands should explain their width, their great intensity and the presence of strong absorption bands shifted towards the violet. The author discusses Beals' hypothesis [see Abstracts 1795 (1930) and 1151 (1932)] for the formation of bright bands, but cannot accept it entirely. The continuous ejection of atoms by radiation-pressure does exist on the surface of a Nova, but there is also another ejection which is irregular and discontinuous, and this one is of the greater importance. Irregular ejection of gaseous material is shown by the rapid shift of the points of maximum intensity within the bands (two plates of spectra of Novæ Lacertæ and Cygni are given). The ejection may be described as "volcanic" since streams of gaseous material (more or less temporary) are projected from the surface of the star, with random explosion giving rise to the maximum of intensity in the spectra. Novæ are therefore unstable stars undergoing physical transformation. A. S. D. M.

2798. Use of Colour-Filters in Visual Photometry of Red Stars. M. G. J. Minnaert and J. van der Bilt. *Roy. Astron. Soc., M.N.* 92. *pp.* 422–438, *March,* 1932.—Estimates of brightness of a red variable star by various observers show systematic differences depending on the star's brightness. The paper is a study of the colour vision of two observers, F. de Roy (DR) and J. van der Bilt (Bl) with respect to artificial stars and U Cygni. As a general rule Bl sees a red variable star brighter than DR. Laboratory experiments show that the difference is small when the stars are very faint and increases with increasing brightness, Bl seeing the red star brighter than DR, but beyond a certain brightness the observers approach one another again. The authors suppose that the systematic differences are due to observers making different uses of the cones and rods in the retinæ of their eyes—the cones being sensitive to the yellow and to bright illumination; the rods adapted to feeble illumination and have their maximum sensibility in the green-blue. Where the stars are faint both observers use their rods, later Bl uses his cones long before DR does with the increasing brightness; when DR's cones come into action the observers agree for the second time. The observers have different "retina-activities"; one fixes the image, the other looks at it aside. The authors obtain an expression for the cones and also for the rods, and deduce a corresponding "brightness." They reduce the filter observations to

" normal magnitudes " and find that the " normal-eye " curves of the two observers agree with each other satisfactorily. The chief requirement of a colour-filter is where two observers using it see the same differences of brightness between stars of various spectral classes, whether they are rod or cone observers; in practice the difference between a cone and a rod observer will be largest when they compare a red with an A0 star. The second requirement is that it should reduce the stars' brightness as little as possible. A. S. D. M.

2799. Distribution of Extra-Galactic Nebulæ. E. P. Hubble. *Science*, 75. *pp.* 24–25, *Jan.* 1, 1932.—A summary of the analysis of 900 E-40 plates made with the Mt. Wilson 100-in. and 60-in. reflectors, yielding about 20,000 nebulæ which seem uniformly distributed in galactic coordinates over the three-quarters of the sky north of dec.—30°. No nebulæ were found in very low galactic latitudes and the evidence is contradictory concerning a uniformly diffused substratum within our own system. The " zone of avoidance " is irregular with range varying from 10° to 40°, and is brought about by the distribution of known obscuring clouds; there is partial obscuration out to ± 40° latitudes in the direction of the galactic centre (long. 330°–340°), but it is very limited in the opposite direction except near the Taurus region. Beyond ± 40° nebulæ are uniform both in the width and depth of space, except for occasional clusters at wide intervals (about one cluster of nebulæ per 30 square degrees); there is no appreciable absorption found in extra-galactic space. The number of nebulæ per square degree is given by $\log N_{sd} = 0{\cdot}6m_{pg} - 9{\cdot}5$, which, with $-13{\cdot}8$ for the mean absolute photographic magnitude of nebulæ, gives a mean density of one nebula per 6×10^{16} cubic parsecs and 5×10^{-31} gm./c.c. as the mean density of nebular material in the observed region of space. A. S. D. M.

2800. Large Magellanic Cloud. Part V. Luminosity Curves for Brighter Super-Giants. H. Shapley. *Harvard Coll. Obs., Bull. No.* 886. *pp.* 9–12, *Feb.* 1, 1932.—An examination in detail of objects of higher luminosity (those brighter than magnitude 12·5) in the Large Cloud. A new comparison star sequence is set up (international scale) for stars from the 9th–13th magnitudes, and 8 new areas, each a half square degree, are chosen in three regions. A table gives the number of stars per square degree for each half-magnitude interval and these are corrected for foreground stars in a second table; diagrams give luminosity curves for the three regions, a preliminary luminosity curve for the entire Cloud, and an average luminosity curve for one square degree; there is also a comparison of the luminosity curves for the three regions. In the clustered regions, stars as bright as the 10th magnitude, corresponding to absolute magnitude —7, are found; in the axis, absolute magnitude —6·5 are recorded (probably in an open cluster superposed on the axis); in the open area super-giants brighter than — 4 are infrequent. [See Abstracts 3765 (1931) and 70 (1932).] A. S. D. M.

LIGHT.

2801. Trichromatic Functions of the Average Eye. W. H. Hamilton and E. Freeman. *Science*, 75. *pp.* 292–294, *March* 11, 1932.—A brief outline of the method of obtaining curves for 68 subjects is given and results shown. For matching the three primary colours, 480, 517 and 670 mμ, there are found to be greater divergences in the red-green direction than in the yellow-blue. This indicates that the macular pigment is only a secondary cause of variation. The paper also discusses the cause of the loss of saturation of mixtures and establishes precise conditions for its occurrence. H. M. B.

2802. Blue Hydrocarbon. M. Badoche. *Comptes Rendus*, 194. *pp.* 1086–1088, *March* 21, 1932.—The action of metallic sodium on 9:11-diphenyl–9:12:10:11-diphenylene–9:11-dihydronaphthalene yields (1) a blue hydrocarbon, melting at 465°, which sublimes unchanged at 260° under low pressure and in chloroform solution shows three absorption bands with maxima at 6100, 5650 and 5200 Å.; the formula $(C_{15}H_8)_2$ is suggested; (2) two colourless hydrocarbons melting respectively at 400° and at 245° (+ $\frac{1}{2}C_6H_6$) or 286–287° (solvent-free), the latter giving a violet, fluorescent liquid. Both of these yield the blue compound on dehydrogenation. T. H. P.

2803. Energy Entering the Second Medium at Total Reflection. A. Rostagni. *Ann. d. Physik*, 12. 8. *pp.* 1011–1014, *March* 10, 1932.—A discussion of energy relationships in the light beam penetrating into the second medium at total reflection. [See also Abstracts 49 (1928) and 381 (1932).] C. B. A.

2804. Numerically Rigid Conception of the Laplace-Oriani Statement. K. Koziel. *Acad. Polonaise Sci. et Lettres, Bull.* 7–10*A*. *pp.* 629–645, *July-Dec.*, 1931. *In German.*—From the Laplace-Oriani statement of the refraction theory one can give that for zenithal distances (z_0) up to 75° the constitution of the atmosphere is practically without influence on refraction and the mean astronomical refraction (R) can be calculated from the formula, $R = \alpha(1-\beta)\tan z_0 - \alpha(\beta - \alpha/2)\tan^3 z_0$ where α is the so-called refraction constant and β is a geophysical constant. The accuracy of this formula is investigated and values are obtained of the maximum error of refraction at zenithal distances up to 75°. Also using $R = K\tan z_0$, where K is the refraction coefficient, values of K are set out for z_0 between 0° and 75°. From these two tables the accuracy of the equation for R is evident. The influence on refraction of increase in the temperature distribution in the atmosphere must also be contained within these tabulated values. R. S. R.

2805. Refraction and Dispersion of Neon and Helium. C. Cuthbertson and Maude Cuthbertson. *Roy. Soc., Proc.* 135. *pp.* 40–47, *Feb.* 1, 1932.—Measurements of the refraction and dispersion of Ne and He have been carried out by the authors with a degree of accuracy at least ten times as great as that attained by them in previous experiments in 1910, longer tubes and higher pressures being used and the measurements extended to the ultra-violet. The mean result for the

refractivity of He for the green mercury line ($\lambda 5462{\cdot}23$) is $(\mu - 1) = 0{\cdot}00003489$. Measurements of the dispersion gave

$$\mu - 1 = (1{\cdot}32614 \times 10^{27})/(38313{\cdot}7 \times 10^{27} - n^2),$$

where $n = V/\lambda$ for the wave-length mentioned. The mean refractivity for $Ne_1(\mu - 1)_{5462{\cdot}23}$ was found to be $0{\cdot}00006725$. From the measurements made and given in a table the dispersion formula was calculated by the method of least squares and the result was

$$\mu - 1 = (2{\cdot}61303 \times 10^{27})/(39160 \times 10^{27} - n^2).$$

An anomaly appears when the figures for the five inert gases are compared. The constants in the denominators of the dispersion formulæ which, on the accepted theory should be proportional to the squares of the free frequencies of the dispersion electrons, decrease from He to Xe, except in the case of neon, for which the frequency is higher than for helium. It seems probable that the architecture of the He and Ne atoms are similar from the point of view of refractive indices, the apparent number of dispersion electrons in Ne being very nearly double the number in He, and the free frequencies differing by only 1·1 %.

J. J. S.

2806. Refractive Index of Solutions of Sulphur in Chlorides of Sulphur. Existence of Polyionic Chlorides. A. Baroni. *Accad. Lincei, Atti*, 15. *pp.* 305–309, *Feb.* 21, 1932.—Previous investigations by chemical and physico-chemical methods are briefly reviewed. The refractive indices of mixtures of sulphur with SCl_2 and S_2Cl_2, heated to 100°, 150° and 200° C. are tabulated, together with the values after the mixtures had been left to stand for six months. It is considered that the results point to the existence of a polyionic chloride S_3Cl_2, and that they disprove the existence of compounds richer in sulphur. J. H. A.

2807. Quarter-Wave Plate for the Ultra-Violet with the Help of Oblique Quartz. G. Bruhat and J. Thouvenin. *Rev. d' Optique*, 11. *pp.* 49–73, *Feb.*, 1932.—A doubly refracting plate of adjustable retardation is obtained by the association of two plates of perpendicular quartz of equal thickness but opposite rotations, the thickness being 100 μ and arranged obliquely to the luminous light beam. By varying the incidence from 15° to 24° the system can be made a quarter-wave thickness for various radiations from 2500 to 6000 Å. The mounting of the compensator, and its regulation and standardisation are described. The standardisation is performed by using various radiations from a powerful Hg arc. The values of incidence which give effectively a quarter-wave plate for different radiations are in satisfactory agreement with those calculated from tables of constants. The retardation introduced by the compensator is practically independent of the rotation ρ produced by each plate but it causes a rotation of the neutral lines with reference to the plane of incidence. The neutral line makes with the plane of incidence an angle ω of the order $\rho/2$, depending on the angle of incidence and wave-length. Values of ω are found experimentally for 2653 Å. for incident angles 8° to 24·5° and the results show that the rotation ρ is not constant. The properties of this plate agree with Gouy's theory where $\rho = \rho_0 \cos^2\gamma$, the angle γ being that between the normal to the extraordinary ray in the quartz and the axis. The quarter-wave plate described is not normal to the

field and for measurements of ellipticity gives an accuracy of only 10 min. It requires a regulator to be put into place which is delicate but when once regulated it is easy to pass from one wave-length to another. R. S. R.

2808. Rotatory Dispersions of Benzene Solutions of d-α-Pinene and l-β-Pinene. J. Rabinovitch. *Comptes Rendus*, 194. *pp.* 855–858, *March* 7, *and p.* 1474, *April* 25, 1932.—The rotatory dispersion of α-pinene in benzene solution corresponds with that to be expected from a binary mixture. The optical activity of β-pinene in benzene appears to be higher than its normal value, while the wave-length of the anomaly in the dispersion curve decreases with decreasing concentration. The results indicate the presence in the solution of a third component which is itself active.
C. B. A.

2809. Optical Properties of a Thin Layer of Nitrobenzene under Electrostatic Tension. A. Cotton and H. Mouton. *Comptes Rendus*, 194. *pp.* 924–926, *March* 14, 1932.—A description is given of a thin vessel constructed to hold a drop of nitrobenzene. The vessel is placed on an insulated support normal to a beam of monochromatic light polarised at 45° to the plates in the vessel and a quarter-wave plate and analyser are used to measure the birefringence. On applying an alternating potential difference of 2000–3000 volts to the plates the birefringence increases progressively to a maximum in 2–3 minutes, showing a kind of saturation, and it remains for 2–3 minutes after the field is cut off. The birefringence increases with the applied voltage approximately according to a parabolic law. The birefringence is much greater for this thin layer of nitrobenzene than for a uniform electrostatic field. The facts are of some importance practically, notably in television apparatus. R. S. R.

2810. Operating Characteristics of the Electro-Optical Shutter. H. W. Washburn. *Phys. Rev.* 39. *pp.* 688–701, *Feb.* 15, 1932.—The electro-optical shutter is employed in the study of the electrical breakdown of gases and liquids. In these studies it is desirable to know the time it takes the shutter to close. A calculation of this time can be made from the electrical constants of the circuit and a knowledge of the rate at which the voltage drops across the spark gap. For some of the experimental conditions it is sufficiently accurate to base these calculations on an electrical circuit which replaces the actual distributed constants by lumped constants. In other cases however the error involved by this assumption is too great. It is the purpose of this paper to present an accurate solution of the electrical circuit taking into consideration that the constants are distributed, and by means of this solution to bring out the following important facts: (1) For relatively large distributed electrical capacities of the Kerr-cell leads the rate of closing of the shutter is greater than indicated by the lumped constant solution. (2) The rate of closing is materially increased by using leads separated only by a sheet of mica instead of spacing them further apart in air. For completeness the results of a few experimental observations are also given and compared with results obtained by calculation. AUTHOR.

2811. Flow Birefringence in Colloids. P. Boeder. *Zeits. f. Physik*, 75. 3. 4. *pp.* 258–281, *March* 31, 1931.—A theory of the double refraction produced by flow in colloids is developed. Since the phenomenon originates in the orientation of rod-like particles, the distribution of orientation of the particles in a liquid between two coaxial cylinders is

first investigated, the factors being taken into account being the Brownian movement, and the motion of shear arising from the rotation of one cylinder. While the two-dimensional problem is solved completely, in the three-dimensional case only an approximate solution is obtained for the quotient of shear-velocity by diffusion constant. The optical significance of the solutions is then discussed, the relation between diffusion constant and the extinction angle for a given velocity of shear being deduced. Some experimental results are given and are compared with theory. C. B. A.

2812. Faraday Effect in Ferromagnetics. H. R. Hulme. *Roy. Soc., Proc.* 135. *pp.* 237–257, *Feb.* 1, 1932.—The rotation of polarised light transmitted through very thin films of ferromagnetics is discussed, using the ordinary simple model for a ferromagnetic. As unit a fraction of the crystal containing a large number of atoms is taken and not each atom separately on account of the importance of the exchange forces. For such a system approximate values for the possible wave-functions in the ground state are found, and in excited states when one quantum of light has been absorbed. Hence are obtained the energy changes and the matrix elements of the polarisation for those (virtual) transitions occurring in the dispersion formula. Due to spin-orbit interaction in the excited states these dispersion formulæ are slightly different for left and right circularly polarised light. Thus the indices of refraction are different and a beam of plane polarised light suffers a rotation. The order of magnitude of the rotation is obtained. This is reproduced by the calculation, and for magnetisations in the region of saturation it was found that the rotation is proportional to the magnetisation and increases with the wave-length of the light. Both these results are experimentally true. J. J. S.

2813. Thermal Variation of Faraday Rotation. P. K. Pillai. *Indian Journ. Phys.* 6. *pp.* 573–579, *Feb.* 29, 1932.—The temperature change of Faraday rotation of aqueous solutions of paramagnetic salts is studied. For most of the substances experimented on, the rotation is very nearly inversely proportional to the absolute temperature. A few show no temperature effect and the rotation remains constant. Ferric nitrate and ferric chloride show an increase of rotation with temperature, the increase being nearly proportional to the temperature. There is no general correspondence between temperature changes of susceptibility and of Faraday rotation. AUTHOR.

2814. Magnetic Rotatory Power of Neon. R. de Malleman, L. Gabiano and F. Suhner. *Comptes Rendus,* 194. *pp.* 861–862, *March* 7, 1932.—The magnetic rotatory power of neon is observed in a tube 720 cm. long at a pressure of 1606 mm. In a field of 935,000 gauss, a double rotation of about $0{\cdot}07°$ was observed for the mercury line $\lambda = 5461$ Å., the corresponding value of Verdet's constant being $1{\cdot}1 \times 10^{-6}$, to an accuracy of about 20 %. This value is substantiated in that it gives for the number of optical electrons $p = 2{\cdot}3$, in close agreement with that deduced from the constants of refractive dispersion. Argon, for which Verdet's constant is eight times as large, has $p = 4{\cdot}3$, also agreeing with the refraction value. For He p would thus be expected to be about $1{\cdot}2$, Verdet's constant then being about one-half that for Ne. The experiment in this case would be extremely difficult, the best conditions only giving a maximum rotation of 5 to 10′. C. B. A.

2815. Temperature Variation of Magnetic Birefringence and Havelock Constant for Fused Organic Substances. C. Salceanu. *Comptes Rendus*, 194. *pp.* 863–865, *March* 7, 1932.—Assuming that the optical and magnetic anisotropies of a molecule are independent of temperature, the Langevin–Born equation for the Cotton–Mouton constant C reduces to $C = K[d(n^2 + 2)^2]/nT$, where d is the density, n the refractive index, and K is a constant independent of the absolute temperature T. For naphthalene, β-methylnaphthalene and phenanthrene, at temperatures near the melting point, $\lambda = 5780$ Å. K is sensibly constant, but begins to vary at higher temperatures. An increase in the case of naphthalene is in harmony with the scattering at high temperatures, which indicates a variation in the optical anistropy. Assuming that the anistropies do not vary with wave-length, the expression reduces to the form of Havelock's law, $C = h(n^2 - 1)^2/n\lambda$, h being a constant. For the same compounds, h is observed to decrease with the wave-length, the decrease being larger for phenanthrene than for β-methylnaphthalene, and in turn greater than for benzene derivatives. C. B. A.

2816. Photodichroism and Photoanisotropy. Part XI. Production of Photodichroitic Mirrors. F. Weigert and F. Stiebel. *Zeits. f. phys. Chem.* 16. *Abt.B.* 2–3. *pp.* 113–122, *March*, 1932.—After illuminating grainless Lippmann plates with red light, the silver after development appears in mirror form. Green and blue light have a much smaller mirror-forming effect. After excitation with polarised light the mirrors show photodichroism and photodi-reflection. The reflecting power is confined to a very thin film of the emulsion which is easily removed and which has a very different sensitivity spectrum from that of the rest of the emulsion. [See also Abstract 4165 (1931).] J. E.

2817. Light-Sensitive Surface Films. F. Weigert and E. Eberius. *Kolloid Zeits.* 58. *pp.* 276–282, *March*, 1932.—It is found that certain emulsions are particularly sensitive to red light and when exposed to such light which is linearly polarised, show dichroism and photodi-reflection. This is thought to be a structural effect and is proved not to be due to development. When a film is rubbed over with the finger, the effect in red light entirely disappears, but returns again if kept moist for a considerable time. A description is given of five active emulsions. It is thought that many new photographic and photochemical phenomena may result from these investigations. H. M. B.

2818. Measurement of Thickness of Crystal Plates by Interference by Varying the Angle of Incidence. A. Marcelin and L. Kowarski. *Comptes Rendus*, 194. *pp.* 865–867, *March* 7, 1932.—Instead of comparing the interference colour in the plate, under normal incidence, with that in a wedge comparator, the colour in the film is now matched against a standard reference colour by altering the angle of incidence of the light, an arrangement which has a number of obvious advantages. A comparison of the old and new methods indicates that the latter is capable of giving the more reliable results. C. B. A.

2819. Brock Process of Aerial Mapping. E. H. Cahill. *J.O.S.A.* 22. *pp.* 111–136, *March*, 1932.—A very full description of the Brock process with details of the theory involved. A. H.

2820. Aerial Stereo-Photographic Mapping Instruments and Methods. C. H. Birdseye. *J.O.S.A.* 22. *pp.* 137–160, *March*, 1932.—A

survey of the various instruments used in aerial stereo-photographic mapping. Methods are discussed and possible instruments and devices for overcoming certain difficulties are suggested. A. H.

2821. Apparatus for Micro-Kinematography on 35 mm. Film. R. P. Loveland. *J.O.S.A.* 22. *pp.* 161–169, *March*, 1932. *Comm. No.* 490 *from the Kodak Research Lab.*—A description with photographs and diagrams of the apparatus. J. E.

2822. Infra-Red Photography. H. Willenberg. *Zeits. f. Physik*, 74. 9–10. *pp.* 663–680, *March* 3, 1932.—The Czerny method of photography in the infra-red is developed. The incident energy is used to vaporise a liquid condensed as a thin film, showing bright interference colours, on a thin basis of an absorbing material. During irradiation, very small changes in the thickness of the liquid film give rise to, and can be measured by, changes in the interference colour, the images thus formed on the film being photographed in an ordinary camera with suitable filters. The sensitivity and the image-sharpness are satisfactory, but long exposures are not yet possible. A number of infra-red spectra and photographs taken by heat radiation are reproduced. [See also Abstract 2158 (1929).] C. B. A.

2823. Remarkable Sensitisation. Lüppo-Cramer. *Zeits. f. wiss. Phot.* 30. *pp.* 313–320, *March*, 1932.—The fogging produced under certain conditions by treatment of photographic plates with copper sulphate is discussed. Experiments on the prevention of such fogging by desensitising dyes such as phenosafranine show that "copper fog" occurs only when red light falls on the plate during development, and that the copper salt acts as a powerful sensitiser to the red rays. This sensitising action is dependent on the developer used: it does not appear with glycin, adurol, rodinol, or pyrogallol, but is pronounced with metol and hydroquinone, and especially with mixtures of these two. Apparently all commercial types of plate may be sensitised to the red by treatment with copper sulphate solution (1 %) for not more than 2 min., but if the copper is removed from the plate by washing no sensitisation occurs. The copper ion greatly accelerates the oxidation of developers, and the actual sensitising agent may be a complex formed between the oxidation products and copper, since the oxidation products of pyrogallol, in absence of a metal, function to some extent as red sensitisers. H. F. G.

2824. Optical Properties of Eyepieces. A. Biot. *Ann. Soc. Sci. de Bruxelles*, 52. *pp.* 5–14, *March*, 1932.—A more detailed theory is given of the Huyghens type of eyepiece, particularly in regard to achromatism, position of the focal plane and the pupil. The usual formulæ are considered and attention is drawn to certain consequences which are often neglected. For weak eyepieces, known as the "compensator" type, the distortion at the edge of the field is very slight when achromatism holds for the C and F rays. The combination of two lenses to produce a unit focal length is considered and a graphical method may be used to find the separate focal lengths and the distance apart of the lenses. H. M. B.

2825. Spicer-Dufay Colour Film Process. T. T. Baker. *Phot. J.* 72. *pp.* 109–116; *Disc.*, 116–117, *March*, 1932.—Describes the origin and nature of the Spicer-Dufay colour film process and gives details of exposure, development and copying. A. H.

2826. Electrical Measurement of Reflection Density. Part II. E. R. Davies. *Phot. J.* 72. *pp.* 118–126; *Disc.*, 126–127, *March*, 1932.—Various aspects of the electrical measurement of reflection density having been already discussed in Part I [see Abstract 2396 (1932)] the present work deals more with the instrumental side of the subject. An instrument embodying a photoelectric cell and a carbon wedge is described and it is shown that the density values obtained by means of it are equal to those given by a visual reflection density meter. The measurements are obtained very rapidly, with a high degree of precision and entire absence of fatigue, and they are automatically plotted to give the characteristic curve of the paper. A. H.

2827. Action of Silver Iodide Nuclei in the Production of Photographic Emulsion. Lüppo-Cramer. *Zeits. f. wiss. Phot.* 30. *pp.* 311–313, *March*, 1932.—The action of silver iodide in reducing the grain size of a silver bromide emulsion has been ascribed to its providing nuclei for the bromide to crystallise upon [see Abstract 107 (1931)]. A similar effect has now been observed when thallous iodide is introduced into a gelatin-gum arabic emulsion of red mercuric iodide. H. F. G.

2828. Temperature Crests in Cando-Luminescence. E. L. Nichols and H. L. Howes. *J.O.S.A.* 22. *pp.* 170–189, *March*, 1932.—Further evidence has been obtained of the existence of brightness maxima in the brightness-temperature curves of oxides heated in the hydrogen flame. These maxima are characteristic of the activators. The experiments afford new evidence of the view that luminescence occurs at temperatures of transformation at which the substance undergoes a structural alteration during which it is susceptible to excitation. J. E.

2829. Light from Solidified Gases. Electron State and Phosphorescence of Gaseous Nitrogen. L. Vegard. *Zeits. f. Physik*, 75. 1–2. *pp.* 30–62, *March* 17, 1932.—With the help of a new phosphoroscope an attempt has been made to determine the presence of the positive and negative nitrogen bands in the phosphorescent spectrum, with negative results. The excitation of solid NO with 6000-volt kathode rays gave such a weak light that after 12 hours' exposure nothing could be obtained on the plate, while a mixture of A with 1 % NO, solidified, gave in fluorescence under the same excitation, not only the ϵ system but also the α system and the N_1 band with great intensity. The phosphorescence of this mixture gave only the ϵ system and the α system. It is considered that the strength of the α system indicates that this corresponds to solid NO. The presence of the ϵ system and the N_1 bands shows that the excitation process is connected with the dissociation of NO and the building up of N_2. With the aid of a fluorspar spectrograph and a vaselined plate the limit of the ϵ system was found and 35 new lines obtained, many of which correspond to processes for which $n_2 < n_1$. The intensity relations in the ϵ system agree with the Franck–Condon theory. A new scheme of electron levels is given for the ϵ system and for the N_1–N_2 and N_2–N_4 series and an explanation suggested for the phosphorescence of gaseous nitrogen. J. E.

2830. Measurements in the Long Wave-Length Infra-Red from 20 μ to 135 μ. R. B. Barnes. *Phys. Rev.* 39. *pp.* 562–575, *Feb.* 15, 1932.—The technique employed in this spectral region is discussed, special emphasis being placed upon the problem of the elimination of shorter wave-lengths. New measurements from 20 μ to 135 μ, which show the

transmission of 11 of the substances most commonly used in the infra-red, are presented and discussed. In the light of new absorptions found in crystalline quartz, the residual-ray measurements from Rubens are discussed. The transmission of sulphur was measured, and between 20 μ and 135 μ, 8 absorption bands were located. These are compared with the Raman effect measurements of Krishnamurti. The question of an ideal substance for coating receiving elements in the far infra-red is also treated. AUTHOR.

2831. Investigations in the Infra-Red Region of the Spectrum. Part V. Absorption Spectrum of Carbonyl Sulphide. C. R. Bailey and A. B. D. Cassie. *Roy. Soc., Proc.* 135. *pp.* 375–391, *March*, 1932.—The symmetrical linear structure of both carbon dioxide and carbon disulphide having been established, the present investigation was undertaken since the chemical and external physical properties of carbonyl sulphide are intermediate, while the lack of symmetry predicts more complex intramolecular relationships. The region investigated lay between 1 and 20 μ, the monochromator method described in Part IV [see Abstract 3805 (1931)] being used throughout. Complete data are given, and a discussion is included of the individual bands and of the fundamental frequencies. The final sections are devoted to the various properties of carbonyl sulphide including the force constants and heat of formation.
H. H. Ho.

2832. Infra-Red Absorption Spectra of Oils. P. Lambert and J. Lecomte. *Ann. d. l'Office N. des Combustibles liquides, No.* 6. *pp.* 1001–1084, 1931.—In the first part a *résumé* of previous work in the infra-red on various oils is given. In the next part the infra-red spectrometer is described [see Abstract 132 (1930)], together with method of use and calibration; also results obtained with various pure substances and comparison with Raman effect. The last section deals with investigation of commercial oils which are shown to be complex mixtures. The oils of 1931 are shown to differ from those of 1929 and the difference is ascribed to improvement in distillation. F. S.

2833. Near Infra-Red Absorption Spectra of Halogen Derivatives of Methane. J. G. Moorhead. *Phys. Rev.* 39. *pp.* 788–795, *March* 1, 1932.—The infra-red absorption spectra of CH_3Cl, CH_3Br, and CH_3I, in vapour form, were measured from 1·5 μ to 3·0 μ. The fine structure of bands in the 2·3 μ region was resolved in the first order. The fine structure of bands in the 1·6 μ region was resolved in the second order, but not in the first. Seven bands were found. AUTHOR.

2834. Absorption and Resonance of the Helium Infra-Red Lines. M. R. Wehr. *Phys. Rev.* 39. *pp.* 796–801, *March* 1, 1932.—The absorption of helium excited at low voltages for its own lines, the 2_3S–2_3P at 10,830 Å., and the 2^1S–2^1P at 20,582 Å., is determined. The percentage absorption of the 2_3S–2_3P line increases when either the exciting current or the pressure in the absorbing tube is increased, and also when either the current or the pressure in the source tube is decreased. When the light to be absorbed is taken end-on from a Geissler tube source, the percentage absorption is much less than when the light is taken off at right angles to the capillary. The changes with source-tube conditions are ascribed to the corresponding variations of the shape and width of the emission line. Observable absorption begins when the exciting voltage

is 25 volts. No absorption is detected at 19·8 volts, the excitation potential of the 2_3S state. The 10,830 Å. line shows strong resonance which is directly proportional to the percentage absorption. The absorption for the 20,582 Å. line is very small. It shows no detectable resonance. AUTHOR.

2835. Infra-Red Absorption Spectrum of Formaldehyde Vapour. J. R. Patty and H. H. Nielsen. *Phys. Rev.* 39. *pp.* 957–966, *March* 15, 1932.—The absorption spectrum of formaldehyde vapour in the infra-red has been investigated with a prism spectrometer to 7·0 μ. In addition to confirming the bands reported by Salant and West at 3·5 μ, 1·8 μ, 1·4 μ and 1·25 μ, a fifth band at 4·8 μ was located. The two regions at 3·5 μ and 4·8 μ have been investigated under higher dispersion using an echelette grating ruled with 3600 lines per inch, and resolved into a fine structure. Polymerisation of the gas into paraformaldehyde was avoided by using a cell that could be heated. The region at 3·5 μ was found to be one of intense absorption and apparently consisting of three partially overlapping bands with centres lying near 3·4 μ, 3·5 μ and 3·6 μ. Of these two appear to have P, Q and R branches where the average spacings between lines is about 3·5 cm.$^{-1}$. The third band consists of only one branch where the spacing is about 28 cm.$^{-1}$. In the 4·8 μ region is a band showing P, Q and R branches and very similar in structure to those at 3·4 μ. The average spacing between lines in the P and R branches is here found to be about 3·1 cm.$^{-1}$. AUTHORS.

2836. Infra-Red Absorption Spectra of Ring Hydrocarbons. P. Lambert and J. Lecomte. *Comptes Rendus*, 194. *pp.* 960–962, *March* 14, 1932.—A comparison is made between the absorption spectra of organic substances of the types of cyclohexane, benzene, cyclohexene, naphthalene and multi-nuclear benzene. In one type the principal regions of absorption are similar, but can be differentiated from each other. The variation from one substance to another is not systematic. In comparing a substance of one type with that from another, identical absorption bands may be found. The cyclohexenes are not intermediate in character between the benzenes and the cyclohexanes as was expected. Many of the substances have a well-marked characteristic absorption band. H. M. B.

2837. Infra-Red Absorption of Rare Earths. R. Freymann and S. Takvorian. *Comptes Rendus*, 194. *pp.* 963–964, *March* 14, 1932.—The near infra-red absorption from 0·82 to 1·16 μ has been investigated for neutral chloride solutions between 8 *N* and *N*/32 with a thalofide cell. No absorption is found for lanthanum and cerium, europium, gadolinium, terbium, yttrium or thulium. Bands were found at 10,182 Å. for praseodymium; 8660, 8755 and 8891 Å. for neodymium, and 9508, 10,869 Å. for samarium. Also 9090 Å., 11,054 Å. for dysprosium, 9742 Å. for erbium and 9400, 9740 Å. for lutecium or ytterbium—probably the former. **Errata,** p. 1112, March 21, 1932. F. S.

2838. Absorption Spectra of the Rare Earths. Part II. Y. Uzumasa. *Chem. Soc., Japan, Bull.* 7. *pp.* 85–91, *March*, 1932. *In English.*—Continuing earlier work [see Abstract 3796 (1931)] it is suggested that absorption spectra furnish the possibility of a rapid estimation of the rare earth salts. The bands, however, are often affected, both as regards position and intensity, by changes in observational conditions such as varying concentration or presence of other substances. A study is accordingly made of the absorption of $Nd(NO_3)_3$ and $NdCl_3$ in various

solvents such as water, methyl and ethyl alcohol, acetone, ether, benzene, etc. The various shifts obtained are discussed and it is suggested that the absorption bands of neodymium salts are shifted by solvent molecules as well as by the anion. A. H.

2839. Fine Structure of the Visible Absorption Bands of Bromine. W. G. Brown. *Phys. Rev.* 39. *pp.* 777–787, *March* 1, 1932.—A group of bands (from $v' = 7$ to $v' = 13$, $v'' = 2$, 3 and 4) in the main absorption band system of bromine ($Br_2^{79,81}$) have been analysed and found to consist of P and R branches only. Branches of the less abundant molecules, Br_2^{79} and Br_2^{81}, showing alternating intensities, have been identified in several cases but owing to insufficient resolution a quantitative determination of the ratio of intensities has not been possible. An accurate calculation of the vibrational isotope shift of band origins has confirmed the quantum numbering previously deduced by the author from measurements of band heads. The numerical values of the vibrational constants have been revised slightly from data on band origins. The analysis gave the following rotational constants for the $Br_2^{79,81}$ molecule:

$B_e'' = 0{\cdot}08091$ $B_e' = 0{\cdot}0596$ $I_e'' = 342{\cdot}1 \times 10^{-40}$ $I_e' = 465 \times 10^{-40}$
$a_e'' = 0{\cdot}00028$ $a_e' = 0{\cdot}00062$ $r_e'' = 2{\cdot}28 \times 10^{-8}$ $r_e' = 2{\cdot}65 \times 10^{-8}$

AUTHOR.

2840. Ultra-Violet Absorption Spectrum of Cyanogen. S. C. Woo and R. M. Badger. *Phys. Rev.* 39. *pp.* 932–937, *March* 15, 1932.—The absorption spectrum of cyanogen gas has been investigated in the ultra-violet down to $\lambda 1800$. In the region $\lambda\lambda 2300$–1820 more than one hundred bands were found which apparently belong to one system with origin probably at 44,900 cm.$^{-1}$. The bands have a pronounced tendency to appear as doublets. The more intense ones are usually broad with edges toward the violet, but many line-like structures appear which are probably Q branches. Some regularities in the spectrum are pointed out and the relation of the ultra-violet spectrum to the infra-red absorption and Raman spectra is briefly discussed. AUTHORS.

2841. Parallel Type Absorption Bands of Ammonia. D. M. Dennison and J. D. Hardy. *Phys. Rev.* 39. *pp.* 938–947, *March* 15, 1932.—The form of the ammonia molecule is discussed together with the theory that all of the vibrational levels of the molecule should be double due to the two equivalent positions of equilibrium of the nitrogen atom. This theory serves to explain the doubling of the $||$ band at $10{\cdot}5\,\mu$ and further predicts that the lines of the $3{\cdot}0\,\mu$ band should also appear as doublets although with a much finer separation. An experimental search is made for the doubling of the $3{\cdot}0\ \mu$ band using an infra-red spectrometer of high resolving power. The effect is found, each fine structure line appearing as a doublet with a mean separation of about $1{\cdot}6$ cm.$^{-1}$. The theoretical intensities of the $||$ type ammonia band are computed, assuming that the hydrogen nucleus possesses a spin of $\frac{1}{2}(h/2\pi)$. When these values are compared with the observed lines of the $3{\cdot}0\,\mu$ and the $10{\cdot}5\,\mu$ bands, a very satisfactory agreement is obtained. This agreement furnishes a strong argument for the theory of the doubling of the ammonia bands. It further proves that those states of ammonia existing in nature have vibration—rotation—nuclear spin wave functions which are antisymmetrical for an interchange of two of the hydrogen atoms. AUTHORS.

2842. Emission Spectrum and Transmission of Metallic Silver. F. L. Mohler. *Bureau of Standards, J. of Research*, 8. *pp.* 357–364, *March*, 1932.—The emission spectrum of silver bombarded by electrons is characterised by a high intensity from the visible to 3600 Å., with a decrease to a very low value beyond 3200 Å. The spectrum emitted by silver bombarded by 100-volt electrons in high vacuum is similar to the emission of a silver probe surface at a low positive potential in a cæsium discharge. Probe emission spectra at different temperatures have been compared and a small effect found which may or may not be a pure temperature effect. The slope between 3600 Å. and 3200 Å. becomes slightly less with a shift towards longer wave-length with increasing temperature. The absorption of a silvered quartz plate has been measured at temperatures between 20° and 490° K. There is a large increase in absorption with increasing temperature limited to the range 3350 to 2950 Å. with a maximum effect at 3100 Å. The effect is a decrease in slope of the violet edge of the selective transmission band with increasing temperature. The results are contrary to a theory proposed by Boeckner and the author [see Abstract 952 (1932)]. The observed change in emission is less and in absorption much greater than the predicted effect. AUTHOR.

2843. Temperature Shift of the Transmission Band of Silver. J. V. Pennington. *Phys. Rev.* 39. *pp.* 953–956, *March* 15, 1932.—It is shown that by Kronig's quantum theory of dispersion in metals it is possible to account for the shift of the frequency at which maximum transmission is found for silver when the temperature is varied. The calculated rate of shift is in fair agreement with experiment. AUTHOR.

2844. Emission and Absorption Spectra of BaF. F. A. Jenkins and A. Harvey. *Phys. Rev.* 39. *pp.* 922–931, *March* 15, 1932.—Comparison of the emission and absorption spectra of BaF under high dispersion shows that all of the known band systems involve the normal state of the molecule. The following electronic terms and vibration frequencies are established: A, $0(\omega_e = 469{\cdot}1)$; B, 11,646·3 and 12,280·4 (437·7); C, 14,064·5 (424·6); D, 19,998·2 and 20,197·2 (455·8); E, 24,152·3 and 26,222·3 (506·6). Terms A and B have already been recognised as $^2\Sigma$ and $^2\Pi$ states, while C is known to be an excited $^2\Sigma$ state. The term D is shown in the present work to constitute an electronic doublet, and another doublet state, E, is identified by the discovery of a new band system in the ultra-violet. Some changes are made in previous assignments of vibrational quantum numbers in the $B \rightleftarrows A$ system. Electronic terms and vibration frequencies for the analogous molecules LaO, SrF, YO, CaF and ScO are tabulated, some of these having been re-evaluated from the original data on the basis of the new interpretation. AUTHORS.

2845. Spectra of Barium and Strontium Hydrides. W. R. Fredrickson and W. W. Watson. *Phys. Rev.* 39. *pp.* 753–776, *March* 1, 1932.—The red BaH bands are photographed with a 21-ft. grating, the source being a metallic barium arc running in a hydrogen atmosphere. The spectrum consists only of the (0,0), (1,1) and (2,2) bands and analysis of the (0,0) band shows the system to be of $^2\Pi \rightarrow {}^2\Sigma$, case(a), twelve-branch type. The Λ-type doubling is large in the $^2\Pi_{\frac{1}{2}}$ state, but small and of opposite sign in the $^2\Pi_{1\frac{1}{2}}$ state, whilst the spin doubling in the $^2\Sigma$ state is regular. The molecular constants are evaluated; the separation of the two $^2\Pi$ sublevels suggests that the state is formed from a com-

bination of the lowest ^3P and ^3D states of the Ba atom. A lower-lying excited level is suggested by a large perturbation. The near infra-red SrH bands (obtained similarly to the BaH bands) consist of three groups; the short wave-length group is a $^2\Sigma \rightarrow {}^2\Sigma$ transition, the other two groups form a $^2\Pi \rightarrow {}^2\Sigma$ transition in which only the (0,0) and (1,1) bands are present. The bands are analysed and the molecular constants are obtained. The doubling in the $^2\Sigma \rightarrow {}^2\Sigma$ band is much the largest yet found in bands of this type. Probable electron configurations are discussed. A. H.

2846. Arc Spectrum of Phosphorus. C. C. Kiess. *Bureau of Standards, J. of Research,* 8. *pp.* 393–401, *March,* 1932.—For theoretical reasons phosphorus is known to have an extensive arc spectrum lying in the infra-red. Previous efforts to record this spectrum have proved unsuccessful owing to lack of sensitivity of the specially prepared photographic plates. Plates prepared by the Eastman Kodak Co. with a new infra-red sensitiser have permitted the hitherto unknown portion of the spectrum to be photographed at the Bureau of Standards. About 40 wave-lengths have been measured between 9100 and 10,800 Å. These have been classified as combinations between quartet and doublet terms, which, without exception, are those required theoretically for the phosphorus atom. A survey of the entire spectrum has revealed the presence of seven new ultra-violet lines which give the connection between the doublet and quartet systems. From the series-forming terms the value of the lowest term $^4S^\circ_{1\frac{1}{2}}$ is found to be 90,000 cm.$^{-1}$, giving an ionisation potential of 11·11 volts. AUTHOR.

2847. Intensity Measurements in the Arc Spectrum of Thallium. S. E. Williams and J. Herlihy. *Phys. Rev.* 39. *pp.* 802–805, *March* 1, 1932.—Intensity ratios for the doublets of the principal series, $2s - mp_{1\frac{1}{2}}$, $2s - mp_{\frac{1}{2}}$, were measured by the photographic method, using a Pfund arc with silver poles. For $m = 4, 5, 6, 7$, the values obtained for $\overline{a_1^2}/\overline{a_2^2}$ were 4·4, 6·6, 6·0, 5·2, deviating substantially from the prediction of the sum rule, and showing the effect discovered by Sambursky in the principal series of the alkalies. Separation of results according to arc currents of 2 amperes and 4 amperes showed no effect due to this factor. For the doublet $m = 4$, the ratio obtained with a copper arc was 2·5. The relative intensities of the stronger components ($2s - mp_{1\frac{1}{2}}$), for values of $m = 4, 5, 6, 7, 8$, were found to be 850, 82, 17·5, 3·2, and 1, respectively. AUTHORS.

2848. Wave-Lengths in the Extreme Ultra-Violet Spark Spectra of Lead and Bismuth. G. Arvidsson. *Ann. d. Physik,* 12. 7. *pp.* 787–819, *March* 4, 1932.—The wave-lengths of the lines emitted by highly condensed sparks (in vacuum) between lead and bismuth electrodes were determined over the interval 200–1400 Å., with an error rarely in excess of 0·03 Å. The lines are classified up to PbV and BiVI, but many more difficultly excited lines were observed and are attributed to still higher states of ionisation. The structure of many of the lines was examined. H. F. G.

2849. Perturbed Series in Line Spectra. A. G. Shenstone and H. N. Russell. *Phys. Rev.* 39. *pp.* 415–434, *Feb.* 1, 1932.—There occur many line series in atomic spectra which do not even approximately fit a Ritz formula. They display either a sudden rise in the value of $n^* - n$ towards high term values or a gradual fall of almost a unit. The latter

type contains an extra term due to some other structure and becomes similar to the first type after the removal of that term. It is shown that all such series obey approximately a series formula of type $\nu_n = R/n^{*2}$, $n^* = \mu + \alpha\nu_n + (\beta/\nu_n - \nu_0)$ in which ν_0 is the wave number of some level of the same type from a different electron structure. The series in the spectra CaI, BaI, HgI, CuI, AlII are discussed in detail. The rules governing the occurrence of a perturbation are more restricted than the simple ones that can be deduced from the results in other perturbation problems. The constant β is always negative and the terms therefore appear to repel each other. The BaI levels $5d6p\,^3\&\,^1P^0D^0F^0$ and the series $6snf\,^1F^0$ are given for the first time. AUTHORS.

2850. Line Reflection Spectra of Solids. F. H. Spedding and R. S. Bear. *Phys. Rev.* 39. *pp.* 948–952, *March* 15, 1932.—A new interpretation of reflection spectra in solids, particularly $SmCl_3 . 6H_2O$, is offered. The appearance of new absorption lines and the strengthening of others in the spectrum of a conglomerate as compared with that of a single crystal is explained as being caused by an increased path length travelled by the light through the crystal rather than by surface atoms as heretofore considered. This increased path results from the high refractive index for the light of wavelength of the absorption lines, which makes it difficult for such a ray, once it has entered a small crystal fragment, to leave. A new phenomenon of reversal of lines from absorption in a single crystal to emission in a conglomerate is described for a multiplet of the $GdCl_3 . 6H_2O$ spectrum. AUTHORS.

2851. Theory of the Excitation of Atomic Mercury by Electron Impact. W. G. Penney. *Phys. Rev.* 39. *pp.* 467–473, *Feb.* 1, 1932.—The probability of excitation by electron impact of the four P levels (2^1P_1, 2^3P_2, 2^3P_1, 2^3P_0) of Hg has been calculated. It is found that, although with increasing velocities the excitation of two of the triplet levels vanishes compared with that of the singlet, that of the middle triplet level approaches a small constant value (1/25) which can be calculated from the singlet-triplet separation. It is also possible to calculate the number of dispersion electrons f for these transitions by the use of approximate wave functions. Although the absolute magnitude of f is too large by a factor 2, the relative magnitudes are fixed by the singlet-triplet separation and are in good agreement with experiment. An estimate is made of the relative probability of excitation of all four P levels for fairly slow electrons, and these are roughly all of the same order of magnitude, the ratios at 10 volts being $7{\cdot}0 : 3{\cdot}5 : 1{\cdot}9 : 0{\cdot}4$. The variation of the cross-sections with voltage are shown in the figure. A brief comparison with experiment is given. AUTHOR.

2852. New Measurements of Output of Light during Collisions with Electrons and Ions. W. Hanle. *Phys. Zeits.* 33. *pp.* 245–247, *March* 15, 1932.—Contains a review of work done in the author's laboratory in Jena, in continuation of his investigations made in collaboration with Schaffernicht and Larché. Thieme has made observations on He and Hg at low pressures which have yielded interesting results, and show that the high pressures previously used produced marked disturbances, which masked the true relations between the excitation functions and the velocity of the electrons. Haft has made measurements with sodium vapour, particularly with the D lines. Fischer has dealt with argon. Thieme has

applied the method to molecular spectra, and in particular to nitrogen and obtained interesting results. Larché has found that certain nitrogen-bands exhibit a maximum of intensity with an electron velocity so high as 2000 volts; these bands naturally do not appear at all under ordinary conditions. Describes apparatus in which ions can be produced, and accelerated in an electric field until their velocity is such that their collisions with gaseous atoms produce light. The excitation functions under these conditions can be compared. H. N. A.

2853. Intensities in Singlet-Triplet Bands of Diatomic Molecules. R. Schlapp. *Phys. Rev.* 39. *pp.* 806–815, *March* 1, 1932.—Obtains intensity formulæ for the rotational structure of bands due to transitions between singlet and triplet states of a diatomic molecule. Such intercombinations occur because the wave functions which diagonalise the orbit-spin interaction contain both singlet and triplet terms. In the transition $^1\Sigma$–$^3\Sigma$ two cases arise, according as the two states have the same or opposite symmetry as regards reflection of the orbital motions in a plane containing the nuclei—different sets of branches appear in the two cases. Comparison is made with measurements of intensities in the atmospheric absorption bands of oxygen; the agreement is satisfactory assuming that the bands are due to dipole transitions from the $^3\Sigma^-$ ground state to a $^1\Sigma^-$ state. Formulæ are found for the transitions $^1\Sigma$–$^3\Pi$, $^1\Sigma$–$^3\Delta$ when the triplet state comes under either of Hund's cases (*a*) or (*b*). A. H.

2854. Relations between Corresponding Quadruplets of NI, OII SII and Cl III. J. Gilles. *Comptes Rendus*, 194. *pp.* 606–607, *Feb.* 15, 1932.—Shows how, given the quadruplets of NI, OII and SII, those of Cl III can be calculated, the error being less than 25 Å. In a similar manner the approximate position of the doublets *ns np*, one of which has already been found by Bowen, can be determined. H. N. A.

2855. Optical and X-Ray Spectra. V. Dolejšek and V. Kunzl. *Zeits. f. Physik*, 74. 7–8. *pp.* 565–573, *Feb.* 23, 1932.—The experiments made by Dolejšek with an ionic tube at 1000 volts d.c. are repeated, but an attempt is made to use higher current intensities. As the current intensity rises, there is a sudden change in the form of the discharge, as in Paschen's experiments with hollow kathodes. The authors constructed tubes which could be so regulated that it was possible to photograph not only optical spectra, but also X-ray spectra with sufficient light intensity. One of these was a Siegbahn type tube with a crystal, the other a vacuum spectrograph according to Osgood with a Rowland grating. In both cases the kathode was made of chrome steel instead of copper, and kathode and anti-kathode were of the same material. Both were water-cooled, as otherwise the kathodes became rapidly used up. It was found possible with one of these tubes to photograph the K series of aluminium with a gypsum crystal using 2000 volts and 100 milliamperes. E. E. F. d'A.

2856. Quantitative Spectrum Analysis. Part III. Cd in ZnO. Part IV. Cu in Pb. A. Iwamura. *Kyoto Coll. Sci., Mem.* 14. *pp.* 327–335, *Nov.*, 1931. *In English.*—Zinc oxide electrodes [see Abstract 2677 (1931)] containing traces (0·02 — 0·001 %) of cadmium have been prepared and subjected to quantitative emission-spectrum analysis by measurement of the density of the photographic image of the line at 2288 Å. Under the conditions employed the sensitivity is $1{\cdot}5 \times 10^{-4}$ %,

and the error is about 7 %. The sensitivity of the method for determining copper in lead is $3{\cdot}5 \times 10^{-4}$ %. Traces of copper forming part of an organic compound may readily be alloyed with lead, cadmium or zinc, and by emission-spectrum analysis the quantity of copper present may be determined. H. F. G.

2857. Molecular Spectra and Spectroscopic Analysis. Part III. Yttrium. G. Piccardi and A. Sberna. *Accad. Lincei, Atti*, 15. *pp.* 309–312, *Feb.* 21, 1932.—An investigation similar to that previously carried out for lanthanum [see Abstract 1984 (1932)]. There is a monoxide which is stable at high temperatures and gives a band spectrum in the orange and red, easily identified. This is more convenient than the arc or spark spectrum of the element, although these also have been analysed, and will detect 0·01 %, but not 0·001 % of yttrium. J. H. A.

2858. Molecular Spectra and Molecular Structure. H. Deslandres. *Comptes Rendus*, 194. *pp.* 1033–1037, *March* 21, 1932.—The work described in former papers [see Abstract 3825 (1931)] is continued. In the formula $\nu = q'd_1/r's'$, s' is the number of exterior electrons excited in one of the atoms and, if all the rings are excited, s' is the atomic number, while d_1 is the universal constant 1062·5 cm.$^{-1}$. (d_1/s') can be excited, or submultiples of it. The results of earlier researches are then extended to find the numbers n for which d_1/n reproduces the molecular frequency. The results obtained for O_2, HF and H_2 are tabulated and identification is obtained with (1) the molecule of O_2 with Raman excitation for O_2^-, O_3, O_5, O_6, O_7^+, O_7^- and O_8; (2) the molecule HF for the first and second rings of $(HF)_2$, F_3^-, $(HF)_3$, F_4^-, $(HF)_5$, FH_4^- and $(FH)_4$; and (3) the molecule H_2 with Raman excitation for H_3^-, H_4, H_5 and H_6. R. S. R.

2859. Wave-Mechanical Theory of Widening of Spectrum Lines. B. Mrowka. *Ann. d. Physik*, 12. 7. *pp.* 753–786, *March* 4, 1932.—The effect of changing forces between gaseous particles is considered in its effect on widening of lines. The paper is mathematical. F. S.

2860. Hyperfine Structure and Nuclear Moments of Mercury. Part II. H. Schüler and E. G. Jones. *Zeits. f. Physik*, 74. 9–10. *pp.* 631–646, *March* 3, 1932.—Continuing the investigation of mercury hyperfine structures given in Part I [see Abstract 864 (1932)], the analysis of eight further HgI lines is completed. The observed components and intensities are in agreement with theoretical expectations with the single exception of λ5461 where agreement is not yet obtained between the intensities of the components of the odd and even isotopes. The possibility of "forbidden" transitions is discussed. Some terms are found whose separations are not the same for both of the odd isotopes, the deviations being as much as 15 % of the separations; the I = 3/2 term separations can be both larger and smaller than those of the corresponding I = 1/2 term. The distances between the centres of gravity of the odd isotopes, which are a measure of the amount of the isotope displacement effect, are given in a table. It is confirmed without exception that the terms for I = 3/2 are always inverted with respect to the corresponding terms for I = 1/2. J. E. K.

2861. Hyperfine Structure of the Resonance Lines of Gallium. D. A. Jackson. *Zeits. f. Physik*, 74. 5–6. *pp.* 291–294, *Feb.* 16, 1932.—The hyperfine structure of the resonance lines of gallium is investigated with a reflection echelon having a resolving power of about 800,000. The line 4033 consists of three components with separations −0·084, 0·00,

and $+ 0{\cdot}099$ cm.$^{-1}$ and intensity ratios $0{\cdot}98 : 1{\cdot}22 : 1{\cdot}00$. The line 4172 apparently has two components, but the resolution is probably incomplete in this case. The results show that the nuclear moment $I = 1/2$ attributed to gallium by Campbell and Bacher is almost certainly incorrect; on the assumption that both gallium isotopes have the same nuclear moment, the value $I = 3/2$ is much more probable. It is possible that the hyperfine structure is more complicated and that $I = 0$ for one isotope; if this should be the case it is not possible to form any definite conclusions about the nuclear moment of the other isotope. [See following Abstract.] J. E. K.

2862. Nuclear Moment of Gallium. D. A. Jackson. *Zeits. f. Physik*, 75. 3–4. *pp.* 229–230, *March* 31, 1932.—It was concluded [see preceding Abstract] that the nuclear moment of gallium is 3/2 if the less abundant isotope Ga^{71} has not the value $I = 0$. Investigation of the structure of the line 2874, $^2P_{1/2}$–$^2D_{3/2}$ shows that both isotopes must have the same magnetic moment, since no component corresponding to an isotope with $I = 0$ is observed. Both isotopes have therefore the nuclear moment $I = 3/2$. J. E. K.

2863. Hyperfine Structure of Thallium Arc Lines. D. A. Jackson. *Zeits. f. Physik*, 75. 3–4. *pp.* 223–228, *March* 31, 1932.—The hyperfine structure of the more important arc lines of thallium is investigated with a reflecting echelon grating of high resolving power; the light source consisted of an electrodeless discharge through a cooled tube containing neon, helium and thallous chloride. The line 5351 is a quartet formed by two narrow doublets of unequal intensity. The line 3776 is a sextet composed of three narrow doublets. Lines of the diffuse series are also found to have a narrow doublet structure. In agreement with the work of Schüler and Keyston [see Abstract 2297 (1931)] the observed structures can be explained by the presence of two thallium isotopes, both having the nuclear moment $I = 1/2$, but whose lines are displaced relatively to one another. J. E. K.

2864. Zeeman Effect of the Potassium Spectrum, KII. A. E. Whitford. *Phys. Rev.* 39. *pp.* 898–904, *March* 15, 1932.—The Zeeman effect of the $3p^54s \leftarrow 3p^54p$ and $3p^54p \leftarrow 3p^55s$ transitions of the KII spectrum has been investigated in an effort to throw light on the failure of the $3p^54s$ configuration to obey Houston's multiplet relations and of the $^3P_2$ $^3P_0$ interval to follow the regular doublet law. The magnetically resolved lines from a Back vacuum arc were photographed in the third order of a 21 ft. grating in a Rowland mounting with a dispersion of 0·89 Å./mm. A special type of potassium press was developed for extruding potassium metal into the arc as needed. Analysis of the results shows that the classification of de Bruin and Bowen is correct. The g-sum for $J = 1$ in the $3p^54s$ configuration is $2{\cdot}57 \pm 0{\cdot}02$ instead of the theoretical value of 2·50. This breakdown of the sum rule is to be expected if the anomalous intervals in this configuration are caused by perturbations due to the overlapping terms of the $3p^53d$ configuration. Incomplete knowledge of the $3d$ levels prevents testing the constancy of the combined g-sums. The $3p^55s$ and $3p^54p$ configurations obey the g-sum rule satisfactorily. AUTHOR.

2865. Fine Structure of the He^+ Line 4686 in Parallel Electric and Magnetic Fields. D. P. Ray-Chaudhuri. *Zeits. f. Physik*, 74. 9–10. *pp.* 711–713, *March* 3, 1932.—In a previous paper [see Abstract 1226

(1931)] the author has shown that the maximum separation of the H_α line in parallel electric and magnetic fields is, from theoretical considerations, of the order 0·008 Å. As this is about the limit of resolution of the best optical appliances available to the author, and as the separation depends upon the fourth power of the atomic number, the analysis is now applied to the He+ line 4686. Values of the energy levels, with and without relativistic correction, are given. The anticipated separation ranges from 0·0003 Å. to 0·0115 Å. J. S. G. T.

2866. Zeeman Effect of Quadripole Lines according to the Dirac Theory. B. Milianczuk. *Zeits. f. Physik*, 74. 11–12. *pp.* 810–824, *March* 11, 1932.—The intensity and polarisation of the Zeeman effect components of quadripole lines is calculated by the Dirac theory. The results agree with those given by Rubinowicz [see Abstract 2837 (1930).] J. E. K.

2867. Transformation Effect of Quadripole Lines. B. Milianczuk. *Zeits. f. Physik*, 74. 11–12. *pp.* 825–847, *March* 11, 1932.—With the help of Darwin's solutions of the Dirac equations the intensities and polarisations of the Zeeman effect components of a quadripole doublet in a moderately strong magnetic field are calculated. It is found that for intermediate fields a breaking-down of the selection rule $|\Delta\gamma| = 0, 1, 2$ and a " magnetic completion of the line groups " is to be expected. The results are applied to the Paschen–Back effect. It is shown that in strong magnetic fields a quartet is to be expected whose outer components ($\Delta m = \pm 2$) are polarised perpendicularly and whose inner components are polarised parallel to the magnetic field. The intensities of the components of the $^2S_{1/2}$–$^2D_{3/2,\ 5/2}$ quadripole doublet are given for $\omega/\Delta\nu_n = 1/10, 1/5, 1/2, 1, 2, 5$ and 10 in a weak and a strong field. J. E. K.

2868. Raman Bands of Water. S. Rafalowski. *Acad. Polonaise Sci. et Lettres, Bull.* 7–10*A*. *pp.* 623–628, *July–Dec.*, 1931. *In English.*—The Raman bands of water are observed using a ring-shaped mercury arc surrounding the tube, so placed that light entered the sides of the tube in a direction away from the spectroscope, so that unscattered light should be lost in the usual horn-shaped end of the tube. In this way the background of the plates obtained was very clear. Results are reported for the bands of water scattered in pure water, solutions of HCl and of HNO_3 of various concentrations. In the case of the HCl solution, the bands of water became less sharp as the concentration increased, while those of HNO_3 became sharper. The bands observed are believed to be triple, and not double, as reported by some observers. Microphotometer records are included in support of the contentions put forward. A. C. M.

2869. Raman Effect in Gases. S. Bhagavantam. *Indian Journ. Phys.* 6. *pp.* 557–562, *Feb.* 29, 1932.—A numerical computation of the intensity of the vibrational Raman scattering in some simple molecules leads to results which are of the same order of magnitude as the experimentally observed figures. There appear, however, to be certain discrepancies between the calculated and observed states of polarisation of these lines. AUTHOR.

2870. Raman Frequency of the Perchlorate Ion in Perchlorates and Perchloric Acid. Hydroxonium Ion. Z. Ollano. *N. Cimento*, 9. *pp.* 51–62, *Feb.*, 1932.—The existence of the ion H_3O^+, especially in perchloric acid, is discussed. The Raman spectra of sodium, potassium

and ammonium perchlorates and of perchloric acid, have been examined. The frequencies characteristic of the perchlorate ion are 1118, 936, 627 and 461 cm.$^{-1}$, but in concentrated solutions of the acid a band at about 3550 cm.$^{-1}$, attributable to the H_3O^+ ion, appears, whilst the H_2O bands vanish. It is probable therefore that in the concentrated solutions the water forms with the acid an ionisable compound $(H_3O)ClO_4$. On dilution of the solution, the band at 3550 cm.$^{-1}$ moves towards that of water at 3600 cm.$^{-1}$. In concentrated solutions of the alkali perchlorates there appears a line at 3590 cm.$^{-1}$ which is probably due to a complex ion $H(H_2O)^+_n$. H. F. G.

2871. Raman Effect in Inorganic Complexes, especially Coordination Compounds. I. Damaschun. *Zeits. f. phys. Chem.* 16. *Abt.B.* 2–3. *pp.* 81–101, *March*, 1932.—A number of inorganic coordination compounds exhibit Raman lines which in all cases are to be ascribed to a vibration within the ammino- or cyano-complex. With some complexes, *viz.*, those free from colour and hence capable of observation under favourable conditions, the intensity of the complex-vibration is about equal to that of SO_4-vibrations; Raman lines are, however, lacking in the case of the transparent complex $Ag(NH_3)_2Cl$. According to Placzek [see Abstract 3484 (1931)] the intensive lines shown by certain ammoniacates and cyanides are indicative of a linking approximating to the apolar type. The absence of complex-vibration with certain chemically analogous compounds points to the non-individual constitution of such complexes. Polyacids of molybdenum and tungsten exhibit distinct Raman lines differing somewhat one from the other, a new means of distinguishing the separate stages of aggregation being thus furnished. The vibrations appearing are ascribed to sub-groups of the anion of high molecular weight. T. H. P.

2872. Raman Effect and Dipole Moment. A. Kastler. *Comptes Rendus*, 194. *pp.* 858–861, *March* 7, 1931.—In general, Raman frequencies diminish on passing from gas to liquid, but the reverse also occurs, *e.g.*, in HCN and in $CH_3 \cdot COOH$. The effects are most marked in polar molecules, being due to the electrostatic fields of the dipoles. The neighbourhood of a negative charge should "weaken" a valency bond, and so diminish the Raman frequency, while positive charges should increase it. The positive centres being surrounded by negative electrons would have little effect, so that, in general, a diminution would be expected on passing to the liquid. In the case of HCN, it is assumed that the neighbouring molecules approach the negative CN with the positive H "head." Displacement of a line without broadening indicates the formation of complexes. These considerations are confirmed by the observations of Gerlach on the NO_3 ion [see Abstract 3439 (1930)] and of Bourgel on the effect of substitution on Raman spectra [see Abstract 1253 (1932)]. C. B. A.

2873. Intense Source for Raman Effect or Fluorescence. F. Almasy. *Phys. Zeits.* 33. *pp.* 221–223, *March* 1, 1932.—A new form of mercury-vapour lamp is described. This is of cylindrical form such that the substance to be investigated can be contained in a central tube. J. E.

2874. Structure of the Rayleigh Rays. E. H. L. Meyer and W. Ramm. *Phys. Zeits.* 33. *pp.* 270–272, *March* 15, 1932.—The scattering of the incident radiation observed during the excitation of the Raman spectra of benzene, toluene and carbon tetrachloride is studied. New

lines, displaced from the primary lines by 0·04–0·06 Å. and of about 0·04 Å. in breadth are observed, and in addition the photographs show a definite continuous background. It is very improbable that the resolution of the primary lines can be interpreted as a Raman effect resulting from rotational vibration. H. F. G.

2875. Photophoresis, Electro- and Magneto-Photophoresis. M. Reiss. *Phys. Zeits.* 33. *pp.* 185–202, *March* 1, 1932.—A valuable summary of the work done on this subject during the last 22 years from the time when Ehrenhaft described and named photophoresis the phenomenon which he observed when small test bodies of the order of magnitude 10^{-4} to 10^{-5} cm. were set in motion when illuminated by a concentrated ray of light. Recently still more interest has been roused in the subject since it has been found possible to observe phenomena of motion in small test particles for the occurrence of which simultaneous action of intensive irradiation and an electric or magnetic field is necessary. In Ehrenhaft's original experiment the test particles were led between two condenser plates and the tension was arranged so that the electric force balanced the weight of the particles which were thus held suspended. When the particles were subjected to a strong concentrated ray of light horizontally on the left and right side alternately, it was found that some particles moved in the direction of the incident ray (positive photophoresis) and others against it (negative photophoresis) in a horizontal direction with a velocity of the order of magnitude 10^{-3} cm./sec. at atmospheric pressure, which answered to a force of the order of magnitude 10^{-10} dyne. Experiment showed that the phenomenon was not due to a flow in the gas. The course of research on this subject is summarised with a short account of recent work on electro- and magneto-photophoresis. The paper is an up-to-date report on the forms of motion of sub-microscopic particles and their significance, a region of physics not yet fully explained and affording rich possibilities for research. A Bibliography of 33 references is appended. J. J. S.

2876. Limit of Radiation Frequency. P. Drumaux. *Ann. Soc. Sci. de Bruxelles*, 52. *pp.* 14–20, *March*, 1932.—Using Planck's relation $l = h\nu$, or Minkowski's $l = ct$, as shown earlier [see Abstract 2584 (1931)], the measure of physical motion can be expressed as a frequency. Proceeding from this a limiting frequency, which gives a wave-length $\lambda = 5{\cdot}68 \times 10^{-25}$ Å. is obtained. The duration of the Compton effect is also obtained. H. M. B.

2877. Gas X-Ray Tube for Crystal Structure Analysis. H. Kersten. *Rev. Sci. Instruments*, 3. *pp.* 145–150, *March*, 1932.—A gas X-ray tube is described which has been designed to produce intense beams for crystal structure analysis. Sufficient cooling is provided to allow large currents to be passed. Cellophane windows are used, and the slit or pinhole system is placed within the vacuum so as to approach near the target. J. T.

2878. Investigation of Reactions between Metals and Metal Sulphides by Means of Kβ-Spectrum of Sulphur. B. Svensson. *Zeits. f. Physik*, 75. 1–2. *pp.* 120–128, *March* 17, 1932.—When the sulphide of a metal, MeS, is laid upon another metal Me′, and the temperature is raised, dissociation takes place and may be followed by recombination. Raising the temperature by laying the sulphide upon an antikathode of another metal in an X-ray tube enables high temperatures to be reached

and the resulting reactions may be studied from the radiations emitted. The author predicts the reactions to be expected for a large number of metal combinations and compares his results with the evidence obtained from published experimental work. There is a very good agreement between the predictions and the results. J. E. R. C.

2879. Absolute Measurement of X-Radiation by the Counter Tube. A. Huppertsberg. *Zeits. f. Physik*, 75. 3–4. *pp.* 231–248, *March* 31, 1932.—Experimental details are given of the tube used. The mode of action of the tube is discussed: its sensitivity is proportional to the exposed surface; and to the intensity of radiation, as shown by altering the current in the X-ray tube, and also the distance. It is shown that for varying wave-length characteristic curves of the electron emission of the metal used are obtained; it is concluded that the counted electrons are produced in the metal wall and that the gases in the interior of the tube play no measurable part. The thickness of the effective layer is defined and measured for Al, from which it is computed indirectly for Fe; the latter is verified experimentally for 0·188 Å. A demonstration is given that the counter enumerates all the radiation quanta absorbed in the effective layer. T. L. M.

2880. Screening Constants for Many-Electron Atoms: X-Ray Term Values: Atomic Scattering Factors. L. Pauling and J. Sherman. *Zeits. f. Krist.* 81. 1–2. *pp.* 1–29, *Jan.*, 1932. *In English.*—Screening constants are discussed and it is pointed out that a complete set could be obtained from X-ray term values and ionisation potentials alone. Failing complete knowledge of term values and ionisation potentials of heavy atoms, a table of size-screening constants for all electrons in all atoms has been prepared partly from theoretical calculations and partly from term values, and thus a detailed interpretation of energy levels of atoms can be attained. It is found that the screening constants for inner electrons are not constant but increase rapidly for large values of the atomic number. From Dirac's theory of the electron this phenomenon is interpreted as a spin-relativity effect. A general expression for the scattering factor for X-rays of a hydrogen-like eigenfunction has been obtained and from it F-values for atoms and ions have been obtained which agree with those calculated by Hartree's method. J. J. S.

2881. Atom Factors. W. Ehrenberg and K. Schäfer. *Phys. Zeits.* 33. *pp.* 97–122, *Feb.* 1, 1932.—A *résumé* of the research of recent years upon atom-factors including the intensity of scattered radiation (especially X-rays) so far as this is due to the atom itself and not to the arrangement of atoms. The paper comprises.—I. Introduction. II. Theoretical basis: (1) the idea of " reflecting power "; (2) computation of the reflecting power (fundamentals, influence of temperature, primary extinction); (3) application to the most important cases (powder-measurements, crystals); (4) relation of the atom factor to the distribution of charges within the atom (general relations, the hydrogen-like atom, methods of Thomas–Fermi and Hartree). III. Experimental data: (1) methods of measurement, the first atom factor determinations, Fourier analysis of the charges, measurements in gases, tabulated data; (2) discussion of the data, dependence of the atom factor on the angle of reflection, comparison with Hartree and Thomas–Fermi; (3) measurements with electrons. A copious Bibliography is added. A. D.

2882. Scattering of X-Rays in N_2, O_2, CO_2, CS_2, NH_3, H_2O. H. Gajewski. *Phys. Zeits.* 33. *pp.* 122–131, *Feb.* 1, 1932.—Experimental data, compared and discussed, and a good Bibliography. It appears that the low scattering of the hydrogen atom modifies the interference effect. A. D.

2883. Scattering of X-Rays by Polyatomic Gases. Y. H. Woo. *Phys. Rev.* 39. *pp.* 555–560, *Feb.* 15, 1932.—Recently Jauncey [see Abstract 3113 (1931)] has shown that the factor F in Compton's formula for the scattering of X-rays by an atom should be the average atomic structure factor F′ instead of the true atomic structure factor. Taking this into account, the general expression for the intensity of total scattering of X-rays by polyatomic gases previously deduced by the writer is modified, replacing F by F′. The theory is applied to the scattering of X-rays by diatomic gases and the theoretical scattered intensity is actually compared with the absolute measurements made by Wollan on the scattering on Mo $K\alpha$ rays by H_2, N_2 and O_2. The values of F and F′ are calculated from the Hartree field. On the whole Wollan's results support the new formula, though the old one represents in each case the general feature of the scattering curve. It is pointed out that, for the scattering by a diatomic gas of like atoms, Jauncey's theory of the scattering of X-rays by polyatomic molecules consisting of atoms of one kind gives results practically identical with those of the present theory, provided the change of wave-length due to the Compton effect is corrected for. A note by **G. E. M. Jauncey** [*ibid.*, p. 561, Feb. 15, 1932] is appended. [See also Abstract 137 (1932).] AUTHOR.

2884. X-Ray Reflection from Inhomogeneously Strained Quartz. C. S. Barrett and C. E. Howe. *Phys. Rev.* 39. *pp.* 889–897, *March* 15, 1932.—Laue spots from quartz crystals undergoing piezoelectric vibrations are found to have a fine structure. The nature of this structure is such as to indicate that the increase of reflecting power of a given crystallographic plane varies greatly from point to point in the crystal, while at a given point in the crystal the reflecting power of different planes is increased in different amounts with a resultant intensity distribution unlike that obtained from a rough-ground surface of the crystal. It is proposed that these effects are due to the existence of strain gradients in the crystal, distributed at random in the rough-ground surface but in definite directions in the case of a vibrating crystal. This view is substantiated by some static tests on inhomogeneously strained crystals. Some specimens of quartz with imperfect interior regions are found to have random strain gradients. The effect on reflected intensity may be accounted for on the basis of a reduction of extinction. The phenomenon is used in the study of modes of vibration of quartz plates. AUTHORS.

2885. Activation of Matter. G. Reboul. *Comptes Rendus,* 194. *pp.* 1122–1124, *March* 29, 1932.—The gases emanating from a semi-conducting cellule [see Abstract 2454 (1932)] appear not to be in electrical equilibrium and only to return to electrical equilibrium with relative slowness. This return to equilibrium is associated with an emission of very absorbable radiations capable of affecting a sensitive plate. These gases from the cellules have the property of communicating their activity to other bodies. A. D.

RADIOACTIVITY.

2886. Heating Effect and Distribution of Radioactive Minerals in the Earth's Crust. B. Willis. *Am. J. Sci.* 23. *pp.* 193–226, *March*, 1932.—Since 1915 several geologists and geophysicists have framed hypotheses regarding the distribution of radioactive minerals in the earth and the heat-effects attributable to them. Holmes, Joly, Chamberlin, Barrel and L. H. Adams have published more or less elaborate discussions. In this article the several hypotheses are considered from the point of view of the method of multiple hypotheses, each of them being briefed and subjected to the test of the verity of its fundamental assumptions. The task is simplified by grouping the theories under two heads, namely those that postulate some regular distribution of radioactive minerals in the globe versus those that assume irregularity of distribution. Reasons are assigned for regarding the former as inconsistent with the facts and consequently unreal, whereas the latter group of discussions appears to contain the seed of fruitful progress toward an understanding of the thermal, eruptive history of the earth. AUTHOR.

2887. Half-Value Period of Uranium-Y. O. Gratias and C. H. Collie. *Roy. Soc., Proc.* 135. *pp.* 299–306, *March* 1, 1932.—Using a U-Y source, contaminated only by the unavoidable quantities of U-X and Io, and measuring the decay at first every 6–7 hr., and then daily for 10 days, by (*a*) an ionisation chamber and electrometer, and (*b*) by a null method, the ionisation current being balanced by a current from a Po source, closely agreeing results give as the half-life period $24{\cdot}0 \pm 0{\cdot}58$ hr. Measurements with an electrometer give high values because saturation is very liable to be incomplete. C. A. S.

2888. Disintegration of Lead by Ultra-Radiation. E. G. Steinke and H. Schindler. *Zeits. f. Physik*, 75. 1–2. *pp.* 115–118, *March* 17, 1932.—It is shown that the spontaneous ionisation shocks are produced by the ultra-radiation in the armour surrounding the ionisation chambers. The high specific ionisation indicates hydrogen nuclei, the range is estimated at 10 cm. of lead. From the frequency of the shocks the sum of the diameters of the colliding particles is deduced as 3×10^{-16} cm., which also indicates hydrogen nuclei. This does not agree with the assumption that electrons are the primary ultra-radiation corpuscles. H. N. A.

2889. Artificial Disintegration by α-Particles. J. Chadwick and J. E. R. Constable. *Roy. Soc., Proc.* 135. *pp.* 48–68, *Feb.* 1, 1932.—Examination was made of protons liberated from F and from Al when bombarded by α-particles from Po. In each case they can be resolved into definite groups and these groups occur in pairs. It may be assumed that the α-particles can enter the nucleus through certain resonance levels. For the F disintegration there must be 2 (possibly 3) levels, and for Al 4. The positions and widths of these resonance levels can be deduced from the experimental results. J. J. S.

2890. Disintegration of Elements by α-Rays from Polonium. M. C. Pawlowski. *J. de Physique et le Radium*, 3. *pp.* 116–126, *March*, 1932.—The emission from various elements at 130° to the direction of incidence, when bombarded with α-particles from polonium was examined

by the scintillation method in a fully described apparatus with arrangement for interposing screens of varying thickness of cellulose acetate in the path of the emission. The number of scintillations per min. for 1 millicurie Po extrapolated for nil absorption and 100 % yield on the ZnS screen, and the paths of the reflected α-rays in cm. are: C 13·8, 0·72; Mg 35·4, 1·61; Al 40·1, 1·75; Si 44·6, 1·84; S 56·1, 1·93; Fe 127·2, 2·54; Zn 167, 2·70; Ag 311, 3·13; Pb 988, 3·38. The number of scintillations plotted against thickness of air traversed indicates emission of protons from atoms of C, Mg, Al, Si and S, but not from Fe, Zn, Ag or Pb. There was no indication of three groups of protons [see Abstract 2421 (1928)]. About 4·2 protons were produced per 10^6 α-particles. C and S do not therefore consist only of α-particles, and emission of protons in this way is a general property of the elements, the energy of the bombarding α-particles being insufficient to cause emission from the heavier elements. [See Abstract 1232 (1929).] C. A. S.

2891. Ionisation Produced by Radon in Spherical Vessels. G. Glockler and G. B. Heisig. *J. Phys. Chem.* 36. *pp.* 769–779, *March*, 1932.—The author discusses the applicability of the extrapolated (4·19, 4·80, 7·09), empirical (3·90, 4·47, 6·60) and concordant (3·70, 4·31, 6·60) ranges of the α-particles from Rn, RaA and RaC, respectively to Geiger's 2/3 power law, $I_p = k[r^{2/3} - (r - p)^{2/3}]$, where I_p is the ionisation over a path p, r the range and k a constant. The concordant ranges are obtained by subtracting 0·492 from the extrapolated ranges. They give satisfactory ionisation curves for $k = 6{\cdot}253 \times 10^4$, but to obtain satisfactory total ionisation (1·55, 1·70 and 2·20 $\times$ 10^5 ion pairs respectively) different values of k (6·478, 6·417 and 6·253 $\times$ 10^4) are necessary. On this basis efficiency factors for 70 % Ra and 93 % RaC decomposing on the wall are calculated. [See Abstract 890 (1932).] C. A. S.

2892. Effects of Ionisation Observed in Presence of Beryllium Rays under Excitation by α-Rays from a Vessel Containing Radon. M. de Broglie, F. D. la Tour, L. Leprince-Ringuet and J. Thibaud. *Comptes Rendus*, 194. *pp.* 1037–1040, *March* 21, 1932.—Using an ionisation chamber connected to an amplifier and oscillograph, it is found that rays from Be produce strong ionising corpuscles of some thousands to 3 $\times$ 10^4 pairs of ions. In considering their formation the effects of the metallic walls of the vessel, or films of moisture on them, are shown to be ineffective, and the effect is a volume one for the vessel used. Tests were also made to find whether phenomena, similar to those of Bothe and Kolhörster with cosmic rays, could be obtained with rays from Be under the action of α-rays. The coincidences under two different methods are greater than can be obtained by pure chance, while the number of double rays is also greater than pure chance. R. S. R.

2893. Fluctuations of the Rate of Emission of α-Particles. L. F. Curtiss. *Bureau of Standards, J. of Research*, 8. *pp.* 339–346, *March*, 1932.—An investigation of the fluctuations in the rate of emission of α-particles from very weak polonium sources (of the order of 3×10^{-12} curie/mm.^{2}) for solid angles approximately equal to 4π has been made, using automatic registration and a special double Geiger point counter. The object was to try to detect the large deviations for weak preparations reported by Pokrowski [see Abstracts 1491 and 2221 (1930)]. The total number of particles counted for two different sources was about 306,700

recorded in fourteen different sets of observations at average rates of from 300 to 45 per min., representing practically the total rate of emission from each source. The values of Q^2 for each set of observations were computed from the expression $Q^2 = \sum_0^x l_x x^2/L - m$, where l_x is the number of equal intervals, each containing x α-particles, m is the average number per interval and L is the number of α-particles observed. This divergence coefficient, which for a random distribution equals unity, varied between 0·828 and 1·110 for the fourteen different sets. The averaging value of Q^2 obtained, however, is 1·004, which indicates that under these conditions there is no appreciable deviation from a purely random distribution.

AUTHOR.

2894. Long-Range α-Rays from ThC′. J. Port. *Zeits. f. Physik*, 74. 11–12. *pp.* 740–743, *March* 11, 1932.—The range and intensity of the α-rays was determined with the Geiger and Klemperer multiplying counter, using a Lutz-Edelmann electrometer. The deflections were recorded photographically. More than 100,000 particles were registered and counted. Two groups of long-range α-particles were observed, group I with range 9·79 cm., and 48·5 in number per 10^6 normal α-particles, and group II with range 11·62 cm. and 193 per 10^6 normal α-particles. The results are compared with those of Meitner and Freitag, Philipp, Nimmo and Feather, Rutherford, Wynn-Williams and Lewis. H. N. A.

2895. α-Rays of ThC. S. Rosenblum and M. Valadares. *Comptes Rendus*, 194. *pp.* 967–970, *March* 14, 1932.—Experiments are continued on ThC with the great electromagnet of the Academie des Sciences [see Abstract 1276 (1932)]. With a better definition they have found another constituent α_5 in the fine structure of the α-rays of thorium, and they have confirmed the existence of α_4. With the same apparatus they have also demonstrated the existence of two new lines in the magnetic spectrum, one at $H\rho = 542$ and the other at $H\rho = 668$ cm./gauss. E. E. F. d'A.

2896. Region of Validity of the Born Theory of Collision Processes. F. Distel. *Zeits. f. Physik*, 74. 11–12. *pp.* 785–809, *March* 11, 1932.—The convergence of the Born process is investigated and the effective cross-section for the collision of an α-particle with an atom is calculated to a second degree of approximation. It is found that the chief criterion for convergency is the velocity, and not the wave-length of the particles. The convergence is bad for α-particles, and better for fast electrons. It is shown that it is sufficient to consider the elastic scattering of α-particles by the potential field of the atom, the polarisation of the atom by the α-particle can be neglected. J. E. K.

2897. Number of Secondary β-Rays Emitted by Radium. E. Stahel. *Comptes Rendus*, 194. *pp.* 608–610, *Feb.* 15, 1932.—A Geiger point counter has been employed, the pressure being so high that all the α- and β-rays were counted. The radium was purified from radon and active deposit, and spread in a thin layer on a plane surface of diamond. The mean number of secondary β-rays emitted for 100 radium atoms disintegrated was found to be $5·0 \pm 1·0$. Other experiments are being made to find the number of γ-rays produced. It is certainly much less than 95 %, and probably only a few per cent. It seems, then, that there are two forms of disintegration, one giving only an α-particle, and the other an α-particle and a γ-ray, or the corresponding β-ray. H. N. A.

2898. Upper Limit of the Continuous β-Ray Spectrum of RaE. K. C. Wang. *Zeits. f. Physik*, 74. 11–12. *pp.* 744–747, *March* 11, 1932.—Takes an absorption curve of the β-radiation of RaE in copper, using a Geiger–Müller counting tube. The upper limit of the radiation is found at an $H\rho$ value of 5300. The number of β-particles whose energy is greater than $H\rho = 5000$ is at most 0·1 % of the total. H. N. A.

2899. Magnetic Spectrum of β-Rays of Thorium-B. S. Y. Sze. *Comptes Rendus*, 194. *pp.* 874–876, *March* 7, 1932.—Reducing the continuous spectrum, and diminishing the width of the lines by a special arrangement, $H\rho$ and intensity for 20 β-rays (6 doublets) of ThB have been determined, $H\rho$ 1398 being taken as standard [see Abstract 113 (1926)]. The corresponding levels of origin and γ-ray energies are tabulated. C. A. S.

2900. Absorption of Hard Monochromatic γ-Radiation. Part II. G. T. P. Tarrant. *Roy. Soc., Proc.* 135. *pp.* 223–237, *Feb.* 1, 1932.—The author's previous investigations, using the monochromatic γ-ray of thorium-C″ with the quantum energy $2{\cdot}649 \times 10^6$ *e*-volts, were made with an ionisation chamber at atmospheric pressure; in the present one the ionisation chamber was filled with nitrogen at pressures ranging between 100 and 120 atmospheres. The absorption coefficients have been determined with 19 elements. Corrections on account of the scattering of the rays by the absorber, and on account of the soft component still present at the filter thickness employed, were small and readily determined. The absorption coefficients of the light elements were 3·1 % greater than those calculated from the Klein and Nishina formula, suggesting either that thorium-C″ sources emit a small intensity of γ-radiation, which cannot be separated by filtering, or that nuclear absorption occurs to a small extent with the light elements, as well as with the heavy ones. The absorption coefficients of the heavy elements are greater than those of the light ones on account of the photoelectric effect and the nuclear interaction. The sum of the two effects can be represented as varying very slowly as the square of the atomic number. H. N. A.

2901. Origin of γ-Rays. (Lord) Rutherford. *Nature*, 129. *pp.* 457–458, *March* 26, 1932. *Paper read before the Royal Institution.*—The various theories and investigations as to the origin of the γ-rays are described, particular attention being paid to the experiments of Lewis and Wynn-Williams, using actinium emanation. The results were in good accord with Gamow's theory. It is suggested that penetrating radiations observed in several cases when light elements are bombarded by α-particles are γ-radiations emitted as the result of the transition of the captured α-particles between different levels. Considerable attention is paid to the effects of the bombardment of beryllium by α-rays, a weak radiation more penetrating in character than the γ-rays from radium being given off. Hydrogen material exposed to this radiation emits swift protons, and swift recoil atoms are liberated from helium, lithium, beryllium, carbon, air and argon. The recent work of Chadwick [see Abstract 2473 (1932)] suggests that the results are not due to a γ-radiation at all, but to a stream of swift uncharged particles or "neutrons." H. N. A.

HEAT.

2902. Heat Waves Through Insulating Walls. E. M. Pugh and F. C. Houghten. *Physics*, 2. *pp.* 93–98, *Feb.*, 1932.—For calculating the flow of heat through walls of buildings the steady-state formula based upon average temperatures has been found inadequate. A solution for the periodic heat flow through such walls is given, which has been simplified so that it depends upon two dimensionless quantities f and βl, which are functions of the physical properties of the walls and the periodicity. Curves are given which make it possible to read off the solution directly as soon as f and βl are known. An experimental check is given. AUTHORS.

2903. Determination of the Thermal Diffusivity of Solids. R. H. Frazier. *Phys. Rev.* 39. *pp.* 515–524, *Feb.* 1, 1932.—The method described utilises a transient heat-flow phenomenon requiring the measurement only of the time-interval and a quantity proportional to the temperature-difference. The theory of the method is fully developed, and apparatus and procedure for meeting the conditions of the theory are described together with methods for eliminating and minimising errors. The results of a test on a nickel specimen are given, showing a precision of about 0·1 %. AUTHOR.

2904. Transport Phenomena in a Degenerate Gas. Part I. D. S. Kothari. *Phil. Mag.* 13. *pp.* 361–379, *Feb.*, 1932. *Supplement.*—Deals with the allied phenomena of diffusion, viscosity and conduction in a degenerate gas, following the classical method of Boltzmann and Lorentz. The various values of the transport phenomena for the cases of both non-degeneracy and degeneracy are summarised in a table at the end of the paper. The application of these results to stellar conditions will be discussed in a later paper. T. B.

2905. Influence of Magnetic and Electric Fields on Heat Transmission through Gases. H. Senftleben. *Zeits. f. Physik*, 74. 11–12. *pp.* 757–769, *March* 11, 1932.—The heat transfer is measured by Schleiermacher's method, in which the heat path is from a wire to a surrounding tube. Both electric and magnetic fields alter the heat transfer, the former increasing, and the latter decreasing it. On plotting $\pm d\lambda/\lambda$, *i.e.*, the fractional change in conductivity, against field strength, the magnetic observations show graphs which tend asymptotically to a limiting value, and they generally show a point of inflection. The electric observations are much more regular curves, approximately parabolæ. The effect varies with the pressure of the gas. It is concluded that the magnetic field affects the conductivity directly, whilst the results observed with electric fields are bound up with the existence of convection in gases. It may be that electric fields promote association of the gas molecules. J. H. A.

2906. Theory of the Cold Frame. G. W. Todd. *Univ. Durham Phil. Soc., Proc.* 8. *pp.* 390–409, *Feb.*, 1932.—The object of the paper is to develop an equation giving the relation between the temperatures θ and θ' of uncovered and glass-covered soil, in terms of radiation incident on the earth's surface, and to calculate from it the temperatures likely to be attained in a cold frame or unheated greenhouse. The ideal case of

an infinite glass sheet over horizontal soil for full radiation is taken first, and corrections then applied for the effects of (1) the variation of the absorption and transmission coefficients with wave-length, (2) glass thickness, (3) sun's altitude and (4) atmospheric radiation. The results show that the ratio of the absolute temperatures $\theta'/\theta = 1{\cdot}2$, and it reaches a limiting value as the thickness of the glass increases. Little is gained by increasing the thickness beyond that usually found on a greenhouse or cold frame. The effect of the time-lag and the reflection of incident radiation are neglected. The method can be used to test the relative values of other transparent materials when used as greenhouse coverings.

R. S. R.

2907. Thermal Properties of Tantalum. C. L. Utterback and L. A. Sanderman. *Phys. Rev.* 39. *pp.* 1008–1011, *March* 15, 1932.—Measurements have been made on the total radiation from very pure, well-seasoned tantalum from 1000° to 2220° K. A spectral temperature scale, $\lambda = 0{\cdot}667\ \mu$, is given up to 2100° K. The variation of the resistance of tantalum has been measured up to 2600° K., and the thermoelectric power of tantalum with pure platinum has been measured up to 692° K.

Authors.

2908. Tellurium-Bismuth Vacuum Radiation Thermocouple. C. H. Cartwright. *Rev. Sci. Instruments*, 3. *pp.* 73–79, *Feb.*, 1932.—A simple method of constructing delicate radiation thermocouples with gold-leaf receivers is described in detail. A tellurium wire $\frac{1}{4}$ mm. long could be easily welded to the receiver by using a condenser discharge. The thermoelectric power of tellurium in its β-modification against bismuth is about 600 μV/° C. The thermocouples are about three times more sensitive than those made with bismuth-alloy wires. Some methods for permanently evacuating the thermocouples are given. Author.

2909. New Correction Formula for Reversible Thermometers. K. Hidaka. *Imp. Marine Obs., Kobe, Japan, Mem.* 5. 1. *pp.* 11–13, *March*, 1932. *In German.*—The new formula

$$dT = \beta(V_0 + T)(T - t)/[1 - \beta(V_0 + T - t)]$$

is given for the stem-correction of deep-sea reversible thermometers, to replace the formula of Feruglio, or that of Schumacher. In it dT represents the correction, T the reading of the instrument, t that of the auxiliary thermometer, β the apparent coefficient of expansion of mercury and V_0 the volume of the detached mercury column to the 0·00° C. mark. The formula gives good agreement with Schumacher's observations. J. H. A.

2910. Specific Heat of Ammonium Salts. J. L. Crenshaw and I. Ritter. *Zeits. f. phys. Chem.* 16. *Abt.B.* 2–3. *pp.* 143–152, *March*, 1932. —Measurements were made, using a Nernst vacuum calorimeter, on ammonium nitrate, sulphate, oxalate, benzoate, cyanide and a mixed crystal of ammonium chloride and bromide. For the purpose of comparison measurements were also made on phosphonium iodide. The temperature range covered was — 100° C. to room-temperature, except in the case of ammonium benzoate and phosphonium iodide, where the measurements were carried down to — 180° C. The main object of the work was the investigation of the abnormal increases in specific heat which occur at certain temperatures in ammonium salts as the result of internal trans-

formations. Ammonium nitrate and sulphate undergo such transformations at $-60{\cdot}4$ and $-50{\cdot}7°$ C. respectively. In the case of the latter it was anticipated on optical grounds that the effect would occur between $-40°$ and $-50°$ C. In the mixed crystal of the chloride and bromide, the transformation temperature was at $-5°$ C., which is higher than that of either of the components. The oxalate, benzoate and cyanide do not show the effect, nor is there any anomaly in the specific heat of phosphonium iodide up to $+20°$ C., though it is possible that it occurs at a higher temperature. L. G. C.

2911. Heat-Capacity Data on Organic Compounds, Obtained with a Radiation Calorimeter. M. E. Spaght, S. B. Thomas and G. S. Parks. *J. Phys. Chem.* 36. *pp.* 882–888, *March,* 1932.—The heats of fusion of nine organic compounds are determined by using a "radiation" calorimeter. The heat capacities of these substances are measured in both the solid and liquid states. Liquid ethyl benzene is shown to have no irregularities in the heat-capacity curve as previously reported. Ethyl azoxy benzoate is investigated for a temperature range of 30° to 150° C. [See also Abstract 3528 (1931).] J. K.

2912. Specific Heats of Saturated Vapours. N. v. Kolossowsky and W. Udowenko. *Zeits. f. phys. Chem.* 159. *Abt.A.* 2–3. *pp.* 161–171, *March,* 1932.—The introduction of slight approximations leads to the formula $C_1 = C_2 - \lambda/T$, where C_1, C_2 are the molecular heats of a vapour in the saturated state and at constant pressure respectively, and λ is the total molecular heat of vaporisation. For purposes of calculation this formula would be far less sensitive to errors of observation than the one usually employed, but at present sufficient data are not available. Partly as an extension from this, partly empirically, the rule is enunciated that the specific heat of a saturated vapour at its boiling-point is negative if its molecules contain less than 10 atoms, and positive if they contain more than 10 atoms. This is verified for fifteen substances so far examined. Acetone, with 10 atoms, has a negative specific heat. From this rule it is then possible to calculate the inversion temperature, at which the specific heat changes sign. This is done for fourteen substances. The formation of clouds of vapour by adiabatic expansion depends upon the sign of the specific heat of the saturated vapour. The experiment forms a test of the rule, and is employed to this end by the authors. J. P. A.

2913. Specific Volumes of Water between 20° and 650° C., also of Ethyl Ether and Ethyl Alcohol between 20° and 400° C. at Pressures from 1 to 2500 kg./cm.^{3}. G. Tammann and A. Rühenbeck. *Ann. d. Physik,* 13. 1. *pp.* 63–79, *March* 26, 1932.—An experimental determination of values as indicated in the title by means of a steel cylinder and delicate recording apparatus. The results of Amagat and Watson are redetermined more accurately, and the final findings are recorded in a complete series of tables. Experimental details are also recorded. The results, given in tabular form, are ready for reference. S. G. B.

2914. Specific Volumes of Gaseous Refrigerants. J. H. Awbery and E. Griffiths. *Phys. Soc., Proc.* 44. *pp.* 115–120; *Disc.,* 126–131, *March* 1, 1932.—The volumes per gramme of various vapours at temperatures between 0° and 40° C. and under the corresponding vapour pressure have been measured. The method consists in permitting the liquid to evaporate repeatedly into an exhausted vessel so that automatically the

vapour is under saturation pressure. The volume of the vessel is known, and the weight necessary to fill it is found from the decrease in weight of the liquid. The substances studied were sulphur dioxide, dichloroethylene, ether, pentane and trichloroethylene. AUTHORS.

2915. Latent Heats of Evaporation of Refrigerants. E. Griffiths and J. H. Awbery. *Phys. Soc., Proc.* 44. *pp.* 121–126; *Disc.*, 126–131, *March* 1, 1932.—The latent heats of evaporation of ethyl chloride, methyl chloride, sulphur dioxide, pentane and dichloroethylene have been measured over temperature ranges lying between $-18°$ and $+25°$ C. The method used is an electrical one, in which a known amount of energy is supplied at constant temperature and the mass evaporated is obtained by weighing. AUTHORS.

2916. Water-Content of Saturated Air at Temperatures up to 100° C. J. H. Awbery. *Phys. Soc., Proc.* 44. *pp.* 143–149; *Disc.*, 149–150, *March* 1, 1932.—The water-content of air which is just saturated has been measured at temperatures from 29° to 94° C. by absorbing the moisture and weighing it. To obtain saturation air was bubbled through water in a thermostatically controlled bath. In some experiments the air was initially below saturation, whilst in others it contained more moisture than would be necessary for saturation at the bath temperature. It was verified that the results agreed in the two cases. AUTHOR.

2917. Solubility of Hydrogen Sulphide in Water from the Vapour Pressures of the Solutions. R. H. Wright and O. Maass. *Canad. J. of Research*, 6. *pp.* 94–101, *Jan.*, 1932.—The vapour pressures of a number of solutions of H_2S in water have been measured at temperatures between 5° and 60° C. A new type of glass diaphragm manometer having several advantages is described, and a Bibliography of flexible glass manometers is given. The results show that Henry's law is not strictly obeyed, and that previously reported values may require correction. Discussion of the results is reserved for a later paper. AUTHORS.

2918. Physical Properties of Lithium Vapour. A. Bogros. *Ann. de Physique*, 17. *pp.* 199–282, *March*, 1932.—The vapour pressure of lithium is measured, between temperatures 459° and 572° C., by a method depending on the Knudsen effusion effect, measurements being made of the rate of flow of the vapour through an atomic jet. The saturated vapour pressure of lithium is found to vary, at these temperatures, from 1·3 to 17·1 baryes (0·13 to 1·71 atmospheres). A value for the heat of vaporisation is deduced from these measurements. It is also shown that the method of atomic jets permits the study of the optical properties of lithium vapour, including optical resonance. The structure of the ray 6708 has been specially observed, and the existence of a third component confirmed, attributable to the isotope Li^6; the position of this component is determined with precision and its relative intensity measured. T. B.

2919. Vapour-Pressure Constant, Entropy and Reversible Dissociation of Ammonia. T. E. Sterne. *Phys. Rev.* 39. *pp.* 993–1007, *March* 15, 1932.—The vapour-pressure constant is calculated by statistical quantum mechanics, whilst the entropy in the solid form is investigated by a quantum calculation of the spherical oscillatory motion of the molecules in a crystal lattice. The vapour pressure constant is $-1·55$

(agreeing with the experimental value $-1\cdot50 \pm 0\cdot04$) if the moments of inertia are properly chosen. The entropy change in the reaction $N_2 + 3H_2 \rightleftarrows NH_3$ is calculated, as well as the equilibrium constant ($-7\cdot17$ against the experimental value $-7\cdot04 \pm 0\cdot10$). J. H. A.

2920. States of Aggregation of Helium. W. H. Keesom. *Acta Physica Polonica*, 1. 1–2. *pp.* 1–22, 1932. *In French.*—Helium has been produced in four distinct states of aggregation, *viz.*, as a solid, gas, liquid I and liquid II. A definite transformation occurs in the liquid state, at 2·19° K. At this point a sudden small change in density and dielectric constant have been found and heat is absorbed at this temperature when the temperature is slowly raised; yet the substance remains liquid. A similar phenomenon has recently been found to occur in ethyl ether, nitrobenzene and carbon disulphide [see Abstract 2483 (1932)]. No explanation is at present forthcoming. Details of experimental work at low temperature are described, with many diagrams. J. P. A.

2921. Theory of Equations of State. T. S. Wheeler. *Phil. Mag.* 13. *pp.* 604–615, *March*, 1932.—The work of dilution of a system containing several kinds of spherically symmetrical charged particles (ions) in thermal equilibrium is evaluated theoretically. The results are applied to the problem of strong electrolytes. J. H. A.

2922. Adiabatic Process of the Thermodynamical System in which the Entropy cannot be Defined. T. Iwatsuki and Y. Mimura. *Hiroshima Journ. Sci.* 2. *pp.* 127–138, *March*, 1932.—A mathematical paper in which, after discussing the concrete process in the general case of a thermodynamical system whose entropy cannot be defined, it is shown that: "In a thermodynamical system of r different perfect gases separated from each other by rigid adiabatic walls, or one of two different perfect gases separated from each other by a flexible adiabatic wall, any state can be reached by two ordinary adiabatic processes and one special adiabatic process which takes place by exchange of heat among the gases leaving the total volume constant." T. B.

2923. Entropy, Reversible Processes and Thermocouples. E. H. Kennard and P. W. Bridgman. *Nat. Acad. Sci., Proc.* 18. *pp.* 237–245, *March*, 1932.—A continuation of the discussion between Kennard [see Abstract 1851 (1924)] and Bridgman [see Abstract 1156 (1930)] on the point at issue in the title. The present note calls attention to the restriction imposed upon the statement that reversible processes never change the entropy of the universe. Kennard discusses the question of an isolable process, and shows that it never changes the entropy of the universe. Two examples are considered in detail—the thermoelectric effects and the gas transpiration engine. Kennard attacks Bridgman's recent proof, and attempts to show that in the case of thermocouples the principle that reversible processes do not alter the total entropy is inapplicable, owing to the insuppressibility of the irreversible phenomena, and that the reversible processes are not therefore isolable. In his reply, Bridgman states that in regard to Kennard's point that if a thermoelectric circuit and a gas transpiration engine were enclosed in two boxes and measurements permitted only from outside, no difference could be found between

the boxes, it might be possible to establish parallelism between the measurable quantities for a particular case or set of conditions, but under varied conditions it would be possible to analyse out of the data obtained, pertaining to the thermoelectric box, a part perfectly reversible in the sense of the discussion, but such analysis would not be possible for the transpiration box. Bridgman maintains that his argument is a legitimate extension of the methods of classical thermodynamics. S. G. B.

2924. Thermodynamic Properties of Solid Solutions of Silver Chloride and Sodium Chloride. A. Wachter. *Am. Chem. Soc. J.* 54. *pp.* 919–928, *March*, 1932.—A method is described for making accurate determinations of potentials in cells containing solid electrolytes. In the lattice of AgCl–NaCl a regular arrangement of the sodium ions is verified. F. I. G. R.

2925. Thermodynamics of the Surfaces of Solutions. J. A. V. Butler. *Roy. Soc., Proc.* 135. *pp.* 348–375, *March* 1, 1932.—An examination is made of the thermodynamical consequences of the hypothesis that the influence of the discontinuity does not extend beyond a surface layer of molecules, the variations of which are subject, when the area of the surface remains constant, to the condition

$$A_1 dn_1^s + A_2 dn_2^s \ldots + A_2 dn_n^s = 0,$$

where n_1^s, n_2^s, etc., are the number of molecules of the substance S_1, S_2, etc., in a given area of the surface layer, and A_1, A_2, etc., their superficial areas. The surface tension is then derived in terms of partial molecular free energies (chemical potentials) and area, and expressions are deduced for particular conditions. Experimental data are included, and in the cases of aqueous solutions of a number of aliphatic acids and esters the data are shown to be not inconsistent with the assumption that the area of the water soluble group is equal, or nearly equal, to that of the water-molecule. The partial free energies of compounds forming a homologous series at equivalent concentrations in dilute aqueous solution increase by approximately equal amounts for each additional carbon atom. Traube's rule is a consequence of this effect. Equations are obtained for cases of dilute solutions containing several solutes, and expressions are given for the effect of changes of temperature and pressure on the partial surface free energies and on the adsorption constants. The conditions of equilibrium are obtained for cases in which some components can be formed out of others, and quantitative expressions are deduced for J. J. Thomson's rule for the effect of capillarity on chemical equilibrium. H. H. Ho.

SOUND.

2926. Transmission of Sound through Partitions. A. H. Davis. *Engineering*, 133. *pp.* 147–148, *Feb.* 5, 1932.—Using as source an electrical loud-speaker giving a frequency range from 250 to 2000, the author has tested a number of simple panels 5 × 4 ft, when covering an aperture in a sound-proof wall. The transmission ratio was given by the fraction of the total incident sound energy which passed through, and the reciprocal of this is the reduction factor; the reduction in decibels is $10 \times \log_{10}$ (reduction factor). A reduction of 1 decibel is about the smallest change which can be detected by the human ear, and a partition which causes a reduction of 60 decibels is required to reduce to inaudibility the sound of an ordinary voice. The panels varied from a sheet of paper to a 4½ in. brick wall, and these gave increased reduction with increased frequency; also, when average values are taken, the sound reduction is proportional to the log (weight of panel) for simple panels. Some particulars about composite panels are added. G. E. A.

2927. Velocity of Sound in Tubes at Audible and Ultrasonic Frequencies. C. B. Vance. *Phys. Rev.* 39. *pp.* 737–744, *Feb.* 15. 1932.—The velocity of sound in air contained in glass tubes ranging in diameter from 0·1 cm. to 3·0 cm. was measured at ultrasonic frequencies over a frequency range from 30 to 200 kilocycles per second by using quartz crystals as sound oscillators, and the Kundt's dust-tube method. The results do not agree with those calculated by use of the Helmholtz–Kirchhoff equation $V^1 = V_0(1 - C/2R(2\pi N)^{1/2})$. An equation of the form $V^1 = V_0(1 - C/D^2 - K/D(N)^{1/2})$ is fairly satisfactory for both audible and ultrasonic frequencies. In this equation $V_0 = 331{\cdot}77$ m./sec. $C = 0{\cdot}001512$, $K = 0{\cdot}174$, N = frequency and D = diameter of the tube. The agreement between experimental and calculated values is better for the larger tubes than for the smaller. AUTHOR.

2928. Noise. K. W. Wagner. *Annales des P.T.T.* 21. *pp.* 222–237, *March*, 1932. *Extract of paper in the Comptes Rendus de l'Académie prussienne des Sciences.*—The effect of noise upon the health and efficiency of human beings is considered at length, and the urgent need for a marked reduction in the noise commonly found in cities and workshops stressed. A brief account is given of the Barkhausen method of noise measurement, followed by references and quotations relating to the work of the Noise Abatement Commission in New York. A description is given of the methods of noise measurement as used in America. The paper concludes with a reference to the work of Mayer at the Hertz Institute, and quotes the results obtained on the sound-absorbing properties of partitions showing that the absorption increases with increasing frequency and with increasing weight per unit area. F. S. B.

2929. Phonic Test for Measuring the Mechanical Intensity of Sound. J. F. Cellerier. *Comptes Rendus*, 194. *pp.* 1067–1069, *March* 21, 1932.—The arrangement (illustrated) consists of the receiving biconical, microphone followed in order by an amplifier, adjustable attenuator, selective filters, valve amplifier, rectifier and ammeter; the whole can be packed in four light boxes. Standardisation is by means of pure sounds from tuning

forks. The apparatus is suitable for measuring the intensity of sounds from musical instruments, motor hooters, or the human voice, or to study the acoustics of a hall, or the deadening powers of various materials. C. A. S.

2930. Maintained Vibration of the Harmonium-Reed. P. Das. *Indian Phys. Math. J.* 3. *pp.* 27–31, *Jan.*, 1932.—A theoretical treatment of the means by which the steady pressure due to the bellows is able to maintain the reed in a state of vibratory motion. The relative position of valve and reed is important as affecting the time taken for a pulse to travel into the bellows and be reflected. Experimental results obtained with a reed supported over a tube of variable length are quoted.
W. H. Ge.

2931. Struck String. M. Ghosh. *Indian Phys. Math. J.* 3. *pp.* 15–25, *Jan.*, 1932.—An extension of previous theoretical work to treat the damped string struck near an end by a yielding hammer when the string is semi-infinite and when the duration of the impact is not greater than $4a/c$, where a is the distance of the struck point for the end and c is the speed of propagation of wave along the string. The damped string of finite length struck at the midpoint by an unyielding hammer where the duration of the impact is not greater than $2l/c$ is also treated. The results agree with those of other workers where comparable. W. H. Ge.

2932. String Oscillator. J. Zahradníček and Z. Žák. *Ann. d. Physik*, 12. 6. *pp.* 662–664, *Feb.* 19, 1932.—A valve arrangement similar to that used by Eccles and Jordan for maintaining a tuning fork in vibration was employed to maintain oscillations in a steel wire. It was found possible to excite the wire in harmonic oscillations through a wide range; a wire 4 m. long and with a tension of 10·3 kg. easily gave harmonics from the 6th to the 24th. A. W.

2933. Physics in Sound Recording. A. Whitaker. *Physics in Industry, Lecture* 17. [24 *pp.*], 1932.—After a brief historical survey of the subject the author deals with the various modern methods of sound recording, more especially from the point of view of the physical principles involved. F. S. B.

2934. Distortions in Sound Films. F. Fischer. *Zeits. f. techn. Physik*, 13. 1. *pp.* 2–8, 1932.—Deals with the distortions of sound reproduction in the two processes of sound film production, in which the picture and sound record are on the same film. The distortions are either linear or non-linear. The chief linear distortions are due to the finite width of slit and the so-called phase distortion. In the case of the non-linear distortions, a pure sine oscillation is falsified by the addition of overtones. Such distortions may be due to the photographic conversion of negative into positive. In piano films various devices are used for correction. Thus, in the "blackening" or "rung" film the average blackening is artificially increased, while in the "black-and-white" or serration process the contrast between black and white is reduced and the amplitude of the record is increased to preserve proportionality to the *forte* passages. This is done by means of the amplitude regulators used in amplification, which automatically regulate loudness and the contrast between black and white. E. E. F. d'A.

ELECTRICITY AND MAGNETISM.

ELECTROSTATICS, TERRESTRIAL ELECTRICITY AND MAGNETISM.

2935. E.M.F.s. Generated by Friction between Two Metals. D. Nukiyama. *Phys. Math. Soc., Japan, Proc.* 14. *pp.* 93–107, *March*, 1932. *In English.*—Rods of various materials, C, Mg, Al, Fe, Co, Ni, Cu, Zn, Cd, Ag, Sn, Pb and Bi, gripped by a metal collar, impinge vertically with variable pressure at various distances from the vertical axis of a horizontal rotating steel plate; plate and rod are in electrical connection through a galvanometer, and a steel wire attached to the rod enables its temperature to be determined thermoelectrically. Curves relating the e.m.f. to the velocity of the point of contact for various pressures, and to pressure for various velocities, are given, showing no definite regularities. C. A. S.

2936. True and Apparent Resistivity of Dielectrics. H. Saegusa and S. Shimizu. *Tohoku Univ. Sci. Reports*, 21. *pp.* 1–28, *March*, 1932. *In English.*—The total current passing between two electrodes through a dielectric is the sum of the conduction and the charging currents. The apparent resistivity should therefore increase as the time for which the potential has been applied increases. An apparatus is described which has been used to investigate this effect in the case of quartz, and plates cut parallel and perpendicular to the optic axis are used. In the former case, saturation of the apparent resistivity is not so easily obtained as in the latter and is not complete after 30 min. (1000 volts applied, plate 0·49 mm. thick). It was expected that during the first 0·01 sec. of charging deviations from Ohm's law might appear [see Goldhammer, Abstract 1661 (1929)], but this effect could not be detected. An investigation is made of the relation between resistivity and temperature and it is found that the total current increases exponentially with temperature. It is shown that the true resistivity also decreases exponentially with temperature increase. [See Abstract 271 (1930).] J. E. R. C.

2937. Residual Charge of Dielectrics. S. Shimizu. *Tohoku Univ. Sci. Reports*, 21. *pp.* 29–58, *March*, 1932. *In English.*—A dielectric is charged with a known p.d. for a known time, then discharged for a known time and an investigation made of the charge remaining upon the dielectric. The residual charge varies with the direction of the applied electric field but is proportional to it for any one direction. It tends to a stationary value with increase of time interval before measurement. The variation of residual charge of quartz when in the region of its transformation temperature is investigated. The author claims to have discovered a new phenomenon, *viz.*, with a charging potential of $\pm$ 400 volts the residual charge for a negative applied potential increases at first with increase of measurement time, then decreases, and finally changes its sign. Increase of temperature enhances the effect. The relation between this "inversion" time and the charging time is investigated. J. E. R. C.

2938. Dielectric Constants of Colloidal Solutions. T. Nanty and M. Valet. *Comptes Rendus*, 194. *pp.* 883–884, *March* 7, 1932.—Experimental details are given of measurements of the specific inductive

capacities of the colloidal solutions of the dyestuffs diamine blue, diamine black and methylene blue, which are respectively: 145, 190, 86. Methyl violet, chrysoidine, dimethylamino-azobenzene, ciba red and ciba orange do not differ from pure water in this respect. **Errata,** *ibid.*, p. 1112, March 21, 1932. H. H. Ho.

2939. Measurement of Dielectric Constants of Liquids by Means of a Crystal-Regulated Resonance Apparatus. H. Ulich and W. Nespital. *Zeits. f. phys. Chem.* 16. *Abt.B.* 2–3. *pp.* 221–223, *March*, 1932. —By means of a newly designed apparatus based on the resonance method, full details of which are included, the dielectric constants at several temperatures and for 80 m. wave-length have been determined for the following liquids: methyl ethyl ketone, dioxan, phenol, methyl chloride, monochloroacetic acid, acetonitrile, methylamine, ethylamine, urethane, and hydrazine. The temperature relationship has also been investigated for methyl alcohol, acetone, ethyl ether, ethylene chloride and chlorobenzene. H. H. Ho.

2940. Dielectric Constants of Metallic Oxides. A. Günther-schulze and F. Keller. *Zeits. f. Physik*, 75. 1–2. *pp.* 78–83, *March* 17, 1932.—The dielectric constants of the oxides (in powder form) of Mg, Ba, Al, Ce, Zr, Th, Ta, Sb, Bi and Cr have been measured by the mixed method at high frequencies. In the case of Al_2O_3, it is shown that this product when precipitated from aqueous solution has a maximum dielectric constant in conjunction with a minimum density, and that after repeated sintering at increasing temperatures the dielectric constant decreases to a minimum value, whereas the density rises to a maximum value. It is very noteworthy that the electrolytically-produced Al_2O_3 coating at an aluminium anode has the minimum dielectric constant corresponding to the highest sintering, an indication that the oxide so formed possesses a high density in accord with its extraordinarily great hardness. With some oxides of higher atomic number, the dielectric constant falls to about the square of the refractive index. Data are included for the last-named relationship. H. H. Ho.

2941. Dielectric Constants of Salts. P. Schupp. *Zeits. f. Physik*, 75. 1–2. *pp.* 84–104, *March* 17, 1932.—The dielectric constants of 20 salts have been measured by the mixed method, the mixture-ratio of the two dielectric liquids filling the condenser, in which the salts now investigated are not appreciably soluble, being varied in such a manner that during the introduction of the powdered salts the capacity of the condenser remains unaltered. The capacities were determined by the suspension method, details of which are given together with the ascertained conditions for reliable results. The products investigated were the carbonates and nitrates of the alkali and alkaline earth metals and the chlorides of the alkali chlorides; the data afford relationships for the periodic system and for the optical refractive indices. H. H. Ho.

2942. Dielectric Constant and Power Factor of Rosin Oil and Ethyl Abietate. S. O. Morgan and A. H. White. *Frank. Inst., J.* 213. *pp.* 313–319, *March*, 1932.—The work reported here extends from power frequencies up to radio-frequencies and shows that essentially the same behaviour is observed over the entire range. The materials studied were typical insulating substances derived from rosin and ethyl abietate. The measuring equipment has been described elsewhere [see Abstract 933

(1931)]. The dipole mechanism suggested by Debye appears to offer the best explanation of the uniformity of the above dielectric behaviour.

H. H. Ho.

2943. Dielectric Constants and Electric Moments in Aqueous Solution. G. Devoto. *Accad. Lincei, Atti,* 15. *pp.* 471–473. *March* 20, 1932.—The possibility of deducing an approximate relation between dielectric constant and electric moment of the solute is given by the existence in aqueous solution of the amphoteric polar form for the aliphatic amino-acids, for which the equilibrium between normal form and polar form may be taken as totally displaced towards the latter. In the higher of these amino-acids, the influence of the elongation of the chain of the dipole is clearly shown; the dielectric coefficient [see Abstract 2056 (1932)] for wave-lengths of about 90 cm. at 25° rises continuously from − 26 for $NH_2 . CH_2 . CO_2H$ to + 73 for $NH_2 . [CH_2]_5 . CO_2H$. In these strong dipoles there exists a distinct proportionality between dielectric coefficient and electric moment. 2 : 5-Dioxypiperazine, which probably has a non-polar structure, has the dielectric coefficient − 10, this corresponding as a first approximation with the value obtained from the dielectric coefficients of the amino-acids by extrapolation. T. H. P.

2944. Dipole Moments of Al, B and Be Halides and Molecular Addition-Compounds. Part IV. W. Nespital. *Zeits. f. phys. Chem.* 16. *Abt.B.* 2–3. *pp.* 153–179, *March,* 1932.—This investigation continues previous work [see Abstract 539 (1932)] of measurements of the dielectric constants in benzene and CS_2 solutions with the object of determining the dipole moments of boron trichloride, aluminium iodide and to a moderate order of magnitude those also of the sparingly soluble salts aluminium chloride, beryllium chloride and beryllium bromide. The moments of the following addition-compounds have also been determined: Al-chloride-ethyl ether, Al-bromide-ethyl ether, Al-chloride-ethylamine, Al-chloride-nitrobenzene, Al-bromide-nitrobenzene, Al-bromide-hydrogen sulphide, Al-chloride-benzoylchloride, Al-chloride-benzophenone, B-trichloride-ethyl ether, B-trichloride-acetonitrile, B-trichloride-propionitrile, Be-chloride-ethyl ether, and Be-bromide-ethyl ether. H. H. Ho.

2945. Dipole Moments, Spatial Structure and Energetic Considerations of Inorganic Halides. E. Bergmann and L. Engel. *Zeits. f. phys. Chem.* 16. *Abt.B.* 2–3. *pp.* 180–182. *March,* 1932.—This paper deals in detail with Hückel's criticisms [see Abstract 1855 (1932)] of the author's previous publication [see Abstract 4269 (1931)], and the conclusion is drawn that Hückel's objections to the formula $a = \sqrt[3]{\frac{3P_E}{4\pi N}}$ do not deal with the kernel of the problem, and that the authors' viewpoint is the first to give a stereochemical significance to the Clausius-Mossotti conception. H. H. Ho.

2946. Uniformity of Distribution of Cosmic Radiation. R. A. Millikan. *Phys. Rev.* 39. *pp.* 391–396, *Feb.* 1, 1932.—More careful and prolonged observations on the small, daily variation before reported [see Abstract 1587 (1931)] in the measured intensities of the cosmic rays, the new observations being made under such conditions as to eliminate the possibility of a slight temperature effect suggested by Bowen and Millikan's recent explanation of ionisation-pressure relations in high-pressure electroscopes, yield the definite result that within the limits of the author's

present observational uncertainty which is of the order of a third of 1 %, the sun has no direct influence on cosmic-ray intensities. New evidence is presented that if observed and apparently systematic variations of the order of a third of 1 % are in fact real, they are best interpreted as the result of small changes in the blanketing effect of the earth's atmosphere due to air currents. AUTHOR.

2947. Cosmic-Ray Ionisation and Electroscope Constants as a Function of Pressure. R. A. Millikan. *Phys. Rev.* 39. *pp.* 397–402, *Feb.* 1, 1932.—The residual ionisation in an electroscope at infinite depth in water, that is, its zero reading, is found to be an inverse function of the pressure. Thus, in a particular electroscope the zero at 1 atmosphere was 5·13 ions/c.c./sec., while at 30·1 it had fallen to 1·2 ions/c.c./sec. Also, when in this electroscope the pressure was changed from 1 atmosphere to 30·1 atmospheres the observed ionisation current rose but 13·80 fold. The same multiplying factor was found for γ-rays and for cosmic rays. Both of these pressure effects are shown to be due to lack of saturation in high-pressure electroscopes, as first explained by Bowen and the author [*Nature*, 128. pp. 582–583, Oct. 3, 1931]. From the multiplying factor found above in the measured ionisation at Pasadena in this 30 atmosphere high-pressure electroscope, the number of cosmic-ray ions at 1 atmosphere (24° C. 74 cm. pressure) in this electroscope at Pasadena is found to be fairly accurately 2·63 ions/c.c./sec. The sea-level value of the ionisation in this electroscope is 2·48 ions/c.c./sec. AUTHOR.

2948. Attempt to Deflect Magnetically the Cosmic-Ray Corpuscles. L. M. Mott-Smith. *Phys. Rev.* 39. *pp.* 403–414, *Feb.* 1, 1932.—This paper reports the results of an experimental attempt magnetically to deviate the high-energy corpuscles associated with the cosmic radiation. With a magnetic analyser involving the use of Geiger-Müller electron counters and the magnetic field in the interior of a magnetised iron bar, it is found that no deviation of the corpuscles which cause the simultaneous discharges of the counters occurs. Calculation of the sensitivity indicates that an observable deviation would have been produced if the corpuscles were electrons of energy 2×10^9 *e*-volts or less or protons of energy 10^9 *e*-volts or less. The difficulties involved in explaining this result are discussed and various possible interpretations are presented. AUTHOR.

2949. Ionisation by Penetrating Radiation as a Function of Pressure and Temperature. A. H. Compton, R. D. Bennett and J. C. Stearns. *Phys. Rev.* 39. *pp.* 873–882, *March* 15, 1932.—To account for the experimental fact that the ionisation of a gas exposed to γ-rays or cosmic rays is not proportional to the pressure, but approaches a limiting value for pressures of about 140 atmospheres, the hypothesis is suggested that at these high pressures the initially formed ions may remain so close together that they frequently reunite under their mutual electrostatic attractions. The probability is calculated for the ions to become separated by diffusion, and formulæ are thus obtained for the saturation ionisation current as a function of pressure. The most satisfactory formula is based upon an arbitrary but reasonable assumption regarding the ranges of the secondary electrons ejected by ionising β-particles. Knowing the variation of ionisation with pressure, this diffusion theory predicts a definite variation of ionisation with temperature. Such a temperature variation is experimentally discovered and is in good

accord with the theoretical prediction. The temperature coefficient is negligible for pressures less than 10 atmospheres, but at pressures over 100 atmospheres the ionisation approaches proportionality to the absolute temperature. AUTHORS.

2950. Cosmic-Ray Particles. G. L. Locher. *Phys. Rev.* 39. *pp.* 883–888, *March* 15, 1932.—Previously a number of thin straight tracks formed in a Wilson cloud apparatus were identified as cosmic-ray particle tracks by means of a Geiger counter. The specific ionisation along these has now been determined and does not exceed 36 ion-pairs per cm. in air at 1 atmosphere. This is less than one-third of the ionisation calculated by Kolhörster and Tuwim, and reasons are given for considering their value erroneous. On 148 stereopictures of tracks attributed to cosmic-ray particles 20 groups of 2 or more such tracks were found. The tracks of a group usually converge to a point near at hand, which suggests they may have a common source. Each group may be due to secondary electrons ejected by one photon. A cosmic-ray photon may interact with an atomic nucleus and eject one or more fast β-particles from it; the convergent groups may then be formed when two or more particles are ejected from one nucleus. J. J. S.

2951. Tables of the Ionisation in the Upper Atmosphere. E. O. Hulburt. *Phys. Rev.* 39. *pp.* 977–992, *March* 15, 1932.—The present paper continues the work on the ionisation of the upper atmosphere due to the ultra-violet light of the sun [see Abstract 2619 (1930)] and takes into account as far as possible the entire meteorology of the upper atmosphere and the effects of recombination, temperature diffusion and the motions of the ions and electrons in the gravitational, electric and magnetic fields of the earth. Tables are presented of the ion and electron densities over the earth. The ionisation at night is worked out more completely than was done previously. After sunset, as a result of temperature diffusion and electric-magnetic drift, the ionised region separates into two banks, one with a maximum of ionisation at about 110 km., and one with a maximum at about 140 km. Quantitative agreement is found with the skip distances and other phenomena of wireless waves and with various facts of terrestrial magnetism. AUTHOR.

2952. Influence of Solar Eclipse upon Upper Atmospheric Ionisation. S. Chapman. *Roy. Astron. Soc., M.N.* 92. *pp.* 413–420, *March*, 1932.—The author has suggested [see Abstract 57 (1932)] that the earth's upper ionised layer (about 220 km. high) is ionised by ultra-violet light, the lower (about 100 km.) by neutral solar corpuscles; Appleton [see Abstract 2099B (1928)] attributes both to ultra-violet ionisation. In this paper it is shown that eclipse observations may settle the question. The moon cuts off the supposed neutral corpuscles more than an hour before the ultra-violet light is stopped; the eclipse effect on the incidence of the corpuscles should be over before the optical eclipse begins and [see following Abstract] the corpuscular track is in a different position from the optical track. In radio transmission no striking change marks out the total from the partial phase. Accepting Milne's and Pike's hypothesis as to the emission of neutral corpuscles from the sun [see Abstracts 2306 (1926) and 1312 (1927)], he shows that at the earth these neutral corpuscles should form a parallel beam, and the cone of total shielding from this beam will at this distance have a 1600-mile section, little less than the moon's diameter, and there will be little penumbral eclipse; the corpuscular

shadow will take about 74 min. to cross the earth. During its passage, if the lower layer is due to these corpuscles, new ion production will cease, and the minimum ion-content will be at the *end* of the corpuscular eclipse. Eclipse of solar ultra-violet differs in its reduction of ion-producing radiation; it is smooth and more gradual, and is greatest about 15 min. after totality (or maximum partial phase); it will spread over a wide area, and there will be little distinction between the total and partial phases. He discusses the 1927 eclipse, especially the notable features nearly coinciding in time with the brief interval of totality; these may merely be a coincidence so far as part of the observations are concerned. A. S. D. M.

2953. Map of Corpuscular Eclipse Track of August, 1932. J. C. P. Miller. *Roy. Astron. Soc., M.N.* 92. *pp.* 421–422, *March,* 1932.—The map is calculated on the assumption that the speed of the solar neutral corpuscles is 1000 miles a second; if the speed is less the corpuscular shadow track will be still farther to the east of the optical track. It is also somewhat to the north. Its central line crosses the Atlantic from Greenland to Northern Africa; the shadow spreads from Canada to Europe and passes across England shortly before sunset. [See preceding Abstract.] A. S. D. M.

2954. Terrestrial Magnetic Activity and its Relations to Solar Phenomena. J. Bartels. *Terr. Mag.* 37. *pp.* 1–52, *March,* 1932.—A homogeneous series of monthly means of terrestrial magnetic activity for the years 1872–1930 is derived and extended backwards in annual means to 1835. The annual variation of magnetic activity and of the relative sunspot numbers is discussed by means of new tests for periods. Only the semi-annual wave in magnetic activity is recognised as physically significant. Its maxima prefer the times when the sun is in the celestial equator and not when the sun's axis is most inclined to the ecliptic. Tests involving the harmonic dial, the probable-error circle and several independent considerations support this view. The close relations between sunspot numbers and terrestrial magnetic activity in the annual and monthly means are discussed, and some general statistical aspects are given for the treatment of correlation between such series with after-effects of which solar and terrestrial magnetic activity are typical. Some inhomogeneities are found in the series of relative sunspot numbers and in areas of sunspots and faculæ apart from a general lag of terrestrial magnetic activity in some sunspot cycles. A break in the homogeneity of the international magnetic character figures in recent years is discovered. The individual 27-day recurrences in terrestrial magnetic activity during 1906–31 and their relations to solar activity are discussed with the help of a graphical day-by-day record. They indicate the existence of persistent active areas on the sun's surface, called M-regions, which in many cases cannot be coordinated with such solar phenomena observed by direct astrophysical methods. The new solar indices for 1928–30 which are so closely related to sunspot numbers show this so exceptionally that correlation of solar and terrestrial magnetic activity is not improved. Observations of terrestrial magnetic activity give information of geophysical influences of solar phenomena traced in astrophysical observations and also supplement these direct observations. R. S. R.

2955. Test Deflections for Variometers and Magnetographs. G. Hartnell. *Terr. Mag.* 36. *pp.* 279–296, *Dec.,* 1931, *and* 37. *pp.* 63–77, *March,* 1932.—Equations are developed describing the deflections of

a suspended magnet produced by a deflecting magnet fixed in any desired position. The distances are assumed large enough to render distribution effects negligible. The equations are applied individually to a declination (D), horizontal intensity (H) and vertical intensity (Z) variometer, and to an assembly of these three variometers which constitute a magnetograph. Under the conditions assumed the equations form a convenient means of testing magnetic instruments. Since these instruments contain one or more magnets as essential parts, their response to magnetic forces, as theoretically deduced, provides a criterion of their merit. The best methods of test for D-, H-, and Z-variometers are suggested. R. S. R.

2956. Seasonal Variations in Magnetic Storms. H. B. Maris. *Phys. Rev.* 39. *pp.* 504–514, *Feb.* 1, 1932.—A new list of magnetic storms for the period 1839 to 1930 has been prepared. This list represents a uniform scale of world-wide disturbances for this entire period. The storms of this list show a seasonal variation in frequency with equal maxima at equinox and equal minima at solstice which follows approximately the cosine curve $y = F(3 + \cos 2\theta)$, where θ is the longitude of the sun measured on the earth's ecliptic. The ultra-violet light theory of magnetic storms regards the storms as being due to three effects: gravitational ion drift currents, dynamo currents due to vertical convection and dynamo currents due to lateral winds. The first two are world-wide effects and when calculated from the theory account for a little less than one-third of the change in magnetic activity. The third effect is local and is estimated to account for a little over a third of the total change in activity. Accidental variations in the occurrence of non-solar magnetic storms with semiannual periods account for the remaining third of the change in magnetic storm frequency. It is to be noted that the difference between winter and summer or spring and autumn activity which has previously been observed is not shown by the storms of the present list. It is concluded that annual variations in magnetic storm activity can be explained as the result of annual variations in the declination of the sun. AUTHOR.

CURRENT ELECTRICITY, MAGNETISM AND ELECTROMAGNETISM.

2957. Conductivity of a Charged Metallic Film. M. Pierucci. *N. Cimento*, 9. *pp.* 33–42, *Feb.*, 1932.—Repeats the experiments of Perkins on the conductivity of metallic films charged to a high positive or negative potential. The films were of tungsten deposited on glass, and were charged by Holtz machines through a high-water resistance. He found a well-marked effect of the charge. It was asymmetrical, the resistance decreasing for a negative charge and slightly increasing for a positive charge. The film cannot have contained more than about 4·2 atomic layers. At 10,000 volts, the number of electrons abstracted from the atoms would be 8·5, whereas the number of valency electrons effecting the electrical conductivity of tungsten is 6 per atom. Apart from the uncertainty regarding the thickness of the film there is, however, a fairly good theoretical agreement. E. E. F. d'A.

2958. Anomalous Variation of the Electrical Conductivity of Quartz with Temperature. S. Shimizu. *Tohoku Univ. Sci. Reports*, 21. *pp.* 59–87, *March*, 1932. *In English.*—The variation of the electrical conductivity with the temperature was studied with quartz plates, one

cut perpendicular to the optical axis, and the other cut parallel to it and also perpendicular to one of the electrical axes. In the case of the parallel plate, by the accumulating charge-method, it was found that the conductivity increases with the temperature, and that at the temperature 573° C. it increases discontinuously; while for the perpendicular specimen, by the potential-fall method, it was found that the conductivity increases with the temperature and also at the temperature 573° C. it shows the sharp point. The parallel specimen also exhibits the same character by the same method, although the increase is much smaller than that of the perpendicular specimen. The conductivity was measured with various applied potentials at several constant temperatures and was found to increase with the applied potential and abruptly at the limit potential.
AUTHOR.

2959. Electrical Resistance of Carbon. Z. Nishiyama. *Tohoku Univ. Sci. Reports,* 21. *pp.* 171–192, *March,* 1932. *In English. Report No.* 286 *from the Research Inst. for Iron, Steel and other Metals.*—An attempt is made to explain an abnormal electrical property of carbon which belongs to a semi-conductor. With pure graphite filaments which were prepared by the deposition of carbon decomposed from CCl_4 and treated at various high temperatures, the electrical resistance was measured at temperatures from 0° to 2000°, and the grain size was examined by X-rays. It is concluded that carbon has originally the same electrical property as metals but that the fineness of the grain causes an apparent anomaly of electrical resistance. A tentative explanation is put forward. AUTHOR.

2960. Current Flow in a Circular Disc. J. H. Awbery. *Phil. Mag.* 13. *pp.* 674–681, *March,* 1932.—The electrical resistance between two potential terminals, lying on a diameter and equidistant from the centre of the disc, is calculated, when the current is led in and out at two other terminals on the same diameter. The current terminals may be at a less or greater distance from the centre than the potential terminals, but in either case are symmetrically situated with respect to the centre. The method used is that of conjugate functions. The alteration in the resistance, due to a slight displacement, either lateral or longitudinal, of an electrode, is also considered. J. H. A.

2961. Measurements with Liquid Helium. Part XIII. Contact Resistance between Supraconductors and Ordinary Conductors. R. Holm and W. Meissner. *Zeits. f. Physik,* 74. 11–12. *pp.* 715–735, *March* 11, 1932. *From the Reichsanstalt.*—Metallic contacts generally have a disturbing surface layer which is hard to remove. The disturbance becomes most marked at very low temperatures, since then the metallic resistance to the spreading of the current into the material is generally small compared with the resistance of the disturbing layer. Platinum can be largely freed from the disturbing substance by glowing it *in vacuo,* so that the contact behaves essentially like a purely metallic one even at the lowest temperatures. A supraconducting contact is possible between supraconductors, either of the same or of different materials (Sn and Pb) without any welding of the substances. When supraconductivity begins the resistance of the disturbing layer vanishes. [See also Abstract 2683 (1932).] H. N. A.

2962. Electron Structure and Properties of Metals. U. Dehlinger. *Zeits. f. Elektrochem.* 38. *pp.* 148–153, *March,* 1932.—The paper

is concerned with the effect on the properties of metals and alloys, of the valency electrons in the atom, and of the rest of the atom. The miscibility of metals and their ability to form intermetallic compounds depend on the number of valency electrons per atom. In the case of a series of metals, notably Hg, Tl and Pb, the valency electrons appear to be abnormally firmly bound. These metals tend to be supraconducting. Other properties of metals, *e.g.*, the atomic radius, the colour and the dependence of magnetic susceptibility on temperature are dependent less upon the valency electrons than on the effect of the rest of the atom. J. T.

2963. Current and Impulse according to the Dirac Theory of the Electron. W. Elsasser. *Zeits. f. Physik*, 75. 1–2. *pp.* 129–133, *March* 17, 1932.—According to the theory of relativity impulse is no longer proportional to velocity. The deviations are calculated, and it is shown that they lead to a new mechanism for the conduction of electricity. An attempt is made to explain supraconductivity as an effect of this kind. J. E. K.

2964. Hall Effect in Solid Mercury. J. T. Serduke and T. F. Fisher. *Phys. Rev.* 39. *pp.* 831–834, *March* 1, 1932.—The Hall effect in solid mercury has been studied by several investigators but with uncertain or negative results. The authors have studied the Hall effect in solid mercury obtaining the mercury in strips 14 cm. long, 2 cm. wide and of various thicknesses down to 0·006 cm. The Hall effect is found to be independent of field strength, current density and thickness of specimen. The average value of the Hall constant R obtained is $-0{\cdot}000784$. The longitudinal effect, if present, was not large enough to be well measured. AUTHORS.

2965. Hall Effect in Gold-Silver Alloys. E. van Aubel. *Zeits. f. Physik*, 75. 1–2. *p.* 119, *March* 17, 1932.—Criticises a paper by Ornstein and van Geel [see Abstract 943 (1932)], and points out an error. J. E. R. C.

2966. Variations of the Hall Effect with the Magnetic Field. C. Bellia. *N. Cimento*, 8. *pp.* 377–383, *Dec.*, 1931. *Zeits. f. Physik*, 74. 9–10. *pp.* 655–662, *March* 3, 1932.—In this mathematical paper, from Sommerfeld's electronic theory of metals, using the same methods as Frank, there is deduced a formula which gives the law of the variation of the Hall effect on the occurrence of a change in the intensity of the magnetic field. The formula represents approximately the results of experiments made by the author on a sheet of Bi and also those of other experimenters. Finally the author, from four different formulæ with concordant results, calculates the number of free electrons per c.c. of the metal. For Bi, for example, the number obtained for n, the free electrons per c.c. of the metal at ordinary temperature is $n = 1{\cdot}2 \times 10^{-19}$. This number may be compared with n_1, the number of atoms in 1 c.c. of the metal. This may be calculated by the formula $n_1 = Nd/M$, where N (Avogadro's number) for Bi $= 6{\cdot}2 \times 10^{23}$, d = density, and M (atomic weight) $= 208{\cdot}5$. Thus $n_1 = 2900 \times 10^{19}$ and hence $n/n_1 = 1/2500$. The number of free electrons is thus much smaller than that of the atoms in the metal. For Bi at the surrounding temperature at times one atom in 2500 loses an electron which remains free in the midst of the metal to serve as the vehicle for the electric current and for the flow of heat. J. J. S.

2967. Thermodynamics of the Four Transverse Magnetic Effects. P. W. Bridgman. *Phys. Rev.* 39. *pp.* 702–715, *Feb.* 15, 1932.—The four transverse effects, namely those of Hall, Ettingshausen, Nernst and Righi-Leduc are subjected to a thermodynamic analysis, and it appears that if the Hall e.m.f. has a temperature coefficient there must be a reversible heating effect when a transverse current flows across a conductor carrying a longitudinal current in a magnetic field. But other arguments show that this heating effect vanishes and furthermore it could not be found experimentally. The consequent vanishing of the temperature coefficient of the Hall e.m.f. involves the existence of a new sort of e.m.f., that is, an e.m.f. in a conductor carrying a current in which the temperature is uniformly changing. Corresponding analysis may be made for the other transverse effects. A thermomotive force connected with the Righi-Leduc coefficient exists in a conductor carrying a thermal conduction current when its temperature changes uniformly. Other relations are deduced connecting the Nernst coefficient and the Ettingshausen coefficient with the new e.m.f. and thermomotive force. The temperature dependence of all these quantities is simply connected and the temperature coefficient of the Hall coefficient vanishes at 0° K. A new account is given of the origin of the major part of the Ettingshausen temperature gradient, which is approximately checked by experiment. Finally, the order of magnitude of various small effects is discussed. The specific heat of a conductor is altered by the presence of an electric current. It is also altered by the presence of an ordinary thermal conduction current.
J. J. S.

2968. Kinetic Interpretation of the Kelvin Relations. E. A. Uehling. *Phys. Rev.* 39. *pp.* 821–830, *March* 1, 1932.—The derivation of the Kelvin relations for the reversible heat development and the thermo-e.m.f. in crystals is shown to depend only on the assumption of the principle of detailed balancing. Restricting assumptions in previous treatments of this subject are removed, and the solution of the integral equation describing the distribution function of the electrons is obtained by a general method. The principle of detailed balancing gives the integral equation an essentially symmetrical kernel and thus a formal solution may be obtained which may be used to derive the electric and heat current equations and to prove certain reciprocal relations from which the Kelvin equations follow. J. J. S.

2969. Influence of Circuit Constants and Frequency on the Characteristics of Gas Discharges at Low Pressure. Y. Asami. *I.E.E., Japan, J.* 51. *pp.* 777–784, *Nov.*, 1931.—A description is given of a further investigation of one of the three types of discharge previously dealt with [see Abstract 1564 (1930)]. This type of discharge is regarded as one in which the supply of ions and electrons is made up by ionisation due to collisions of pendulating electrons with the gas molecules. A. W.

2970. Langmuir Probe Measurements in the Normal Copper Arc. E. H. Bramhall. *Phil. Mag.* 13. *pp.* 682–704, *March*, 1932.—Langmuir's theory of a collector in an ionised gas is applied to the normal arc in air, the collector being a fine platinum wire made to swing horizontally through a section of the arc. The volt-ampere probe characteristic is obtained by interposing between the kathode and probe a small alternating potential superimposed on a direct potential of suitable magnitude

and recording the current on an oscillograph. The density of the drift current is found to be of the order of 100 times that of the random current, which leads to the conclusion that the temperature motion of the electrons is relatively unimportant. This complicates the interpretation of the probe characteristic according to the collector theory, so that although satisfactory measurements of space potentials in the arc are secured, it is possible to obtain only rough approximations to the electron density and energy. The results indicate a density of the order of 7×10^{11} per cm.^{3} and an average energy of 2 volts. The voltage gradient between the kathode fall space and the anode glow is found to be non-uniform, increasing greatly close to the electrodes. By extrapolation a kathode fall within the range 11 to 13 volts is found, which is comparable with the ionising potential of copper vapour. It is shown that equations similar to those of Ayrton and Steinmetz for the arc characteristics are untenable when the arc length is short, on account of the variation of the average gradient with length. A. W.

2971. Measurement of Kathode Fall in Mercury-Vapour Discharges. J. Kömmnick and E. Lübcke. *Phys. Zeits.* 33. *pp.* 215–218, *March* 1, 1932.—Accurate measurements with a cylindrical probe in the neighbourhood of the kathode of a mercury-vapour arc show a dependence of the space potential, and hence also of the kathode fall, on the temperature of the mercury kathode. The results are given in graphical form and include measurements with probes at various distances from the kathode above 2 mm. The kathode fall was found to lie between 9 and 11·3 volts. The difference between these results and the value of 10 volts determined by Lamar and Compton is probably due to differences of pressure or of the vapour density of the mercury. A. W.

2972. Periodic Movements of the Negative Glow in Discharge Tubes. W. A. Leyshon. *Phys. Soc., Proc.* 44. *pp.* 171–187; *Disc.*, 188–189, *March* 1, 1932.—An account is given of experiments designed to discover the cause of the jumping-glow phenomenon in discharge tubes. It is shown that the effect is produced when traces of hydrocarbon vapour are present in the tube in addition to the filling gas (neon, in most of the experiments here described). Some effects of such traces of vapour on the characteristics of the tube are given. It is suggested that the phenomenon of the jumping glow may be due to internal flashing at that part of the surface of the kathode which is not covered by negative glow. The flash may be caused by the electrical breakdown of a partially insulating hydrocarbon layer, as a result of the collection of positive ions, or by a surface chemical action occurring when the reaction-products of the discharge have reached a certain concentration at that surface. It is supposed that the electron emissivity of the surface is increased by the flash, and that the main glow jumps to the activated surface. The process is reversible and hence may be periodic. Observations connecting the periodic time of jumps with the current through the tube are in support of this explanation, as also are other experimental results described in the paper. Author.

2973. Extension of Paschen's Law to include the Electrodeless Glow Discharge. O. Stuhlman, Jr. *Frank. Inst., J.* 213. *pp.* 273–282, *March*, 1932.—It is shown that the same critical form of the electrodeless glow discharge can exist at low pressures whether excited in a tube

with loose external sleeve electrodes or completely free from electrodes, provided the exciting field is predominantly electrical. For pressures in excess of the critical pressure characteristic of the gas, the results show that in general Paschen's law can be extended to include the glow discharge, as excited by a h.f. electrical field under both initiating and maintenance conditions. For pressures less than the critical pressure both initiating and maintenance conditions run parallel and the field strength necessary to achieve these results increases very rapidly to very high values. The ratio of field strengths to initiate and maintain the glow discharge for a given pressure and frequency of excitation is constant and characteristic of the gas, provided the field strength is not sufficiently great to produce in the gas its next higher excitation stage usually referred to as the ring discharge, subject to the conditions that the size, shape and material of the container is the same and that the gas is at least spectroscopically pure. The results possess theoretical significance in so far as they point to the conclusion that a pancake coil, contrary to expectations, will, if excited by small currents but h.f. oscillations, maintain a predominant electrical field at its centre. A. W.

2974. Cold Temperature Glow. A. Güntherschulze and H. Betz. *Zeits. f. Physik*, 74. 9–10. *pp.* 681–691, *March* 3, 1932.—By cold radiation is meant radiation normally attributed to high temperatures arising at normal temperatures. One radiation of this type arises in the glow of the anode of an electrolytic rectifier. The glow commences, for aluminium at a sufficiently great current density, at about 2·3 volts, and for other metals at 20 to 50 volts. In the case of aluminium the surface brightness of the glowing electrode rises at first with the seventh power of the voltage. An analysis of the behaviour of aluminium in dilute citric acid is given, and it is shown that the concentration of the electrolyte is immaterial. G. E. B.

2975. Spectral Zones of Light in Front of the Kathode of a Glow Discharge. A. Güntherschulze and F. Keller. *Zeits. f. Physik*, 75. 1–2. *pp.* 105–108, *March* 17, 1932.—The production of a very narrow and sharply defined bright-green zone in the Aston dark space in front of a kathode containing magnesium has previously been described [see Abstract 200 (1932)] and this has been connected with the excitation function of the green magnesium line. Further research with other electrode materials has shown that similar sharply defined luminous zones are obtained with sodium and lithium kathodes. In the case of sodium the zone is yellow and is related to the excitation function of the yellow sodium line. The zone for lithium is red and due to the red lithium line. Kathodes of Zn, Cd and Tl showed no such zones. In the case of a Cs kathode a zone could be distinguished, but the intensity of the light was so weak that no measurements could be made. A. W.

2976. New Method of Measuring the Time of Afterglow of Gas Discharge. L. Rohde and K. Schnetzler. *Phys. Zeits.* 33. *pp.* 206–207, *March* 1, 1932.—The gas discharge is operated by a rectified h.f. circuit which is also applied unrectified to a double Kerr cell so that in one half of the cycle one half of the cell is dark—if the luminosity in the tube ceases immediately the discharge ceases. The shortest time of afterglow that can be measured by this arrangement is $2 \cdot 5 \times 10^{-9}$ sec. In Ne at 3 mm. pressure the light decays to one-third in 3×10^{-7} sec.,

in air at 1 mm. in 4×10^{-7} sec. It was also found by applying both half-waves to a discharge tube showing striæ that successive striæ are excited by opposite halves of the wave. J. E.

2977. Theory of the Positive Column in Diatomic Gases. R. Holm. *Zeits. f. Physik*, 75. 3–4. *pp.* 171–190, *March* 31, 1932.—Observational data on the gradient in the positive column, obtained by Günther-schulze and by the author, are reviewed and corrected and then compared with the values calculated from Schottky's theory. The theoretical assumptions appear to be thoroughly well founded. The sharpness of the positive layers in H_2 and moderately pure N_2 is attributed to the formation of clusters of electrons, and the probability (w) of such formation is found to have a value close to that established in other ways for air, namely, $w = 10^{-6}$ per impact in weak fields. A. W.

2978. Canal Breadth of Electron "Avalanche." F. Ollendorff. *Arch. f. Elektrot.* 26. *pp.* 193–199, *March* 22, 1932.—The breadth of the canal of an electron "avalanche," such as a lightning flash, is estimated from static considerations relative to the confluence of electrons with gas molecules. It is found that the breadth of the canal relative to the spark-gap width depends only on the specific thermal energy of the electrons and on the total potential in the discharge path. Numerical examples are given which show that the canal dimensions found in the above way are in good agreement with experimental measurements. [See also Abstract 564 (1932).] A. W.

2979. Effect of Electron Attachment on Ionic Mobility Curves by the Zeleny Air-Blast Method. L. B. Loeb and N. E. Bradbury. *Frank. Inst., J.* 213. *pp.* 181–194, *Feb.*, 1932.—In a recent paper Zeleny [see Abstract 574 (1932)] published curves obtained for ion mobilities at different ion ages in relatively pure N_2, using his classical air-blast method. Two features are of especial interest: one the apparent gradual displacement of the negative ion peak to lower mobilities as the ion age increases, and the other a marked asymmetry of the electron peak on the low mobility side. This Zeleny interprets as an unresolved negative ion mobility of value about 100 cm./sec. per volt/cm. Such a mobility can only be explained by a carrier that is ion part of its life and electron part of its life, the electronic and ionic phases alternating frequently. The writers indicate that the latter interpretation cannot be correct on the basis of the energies and probabilities involved in electron attachment. Analysis shows that the whole series of the observed phenomena in N_2 by this method are successfully accounted for on the proper application of the simplified theory of electron attachment to the air-blast method. AUTHORS.

2980. Charge-Interchanging and Ionising Cross-Sections of Argon with Respect to Argon Positive Ions. F. Wolf. *Zeits. f. Physik*, 74. 9–10. *pp.* 575–592, *March* 3, 1932.—The charge-interchanging and ionising cross-sections of A are measured with respect to A^+ ions whose volt-velocities range from 20–1000. Graphs and tables connecting the velocities of the beam of ions with the quantities of both kinds of charge which they produce are exhibited and from them the curves giving both cross-sections are deduced. The charge-interchanging cross-section shows a maximum at 40 and a minimum at 460 volts velocity. Its values are throughout somewhat less than the cross-sections for collisions between neutral argon atoms. Argon$^+$ begins to ionise argon at volt-velocities

near 300. The ionising cross-section of the gas slowly grows with increasing velocity, not attaining a maximum. Its final value near 1000 volts is about one-tenth of the charge-interchanging cross-section. N. D.

2981. Stationary Velocity Distribution of Electrons Diffusing in an Electric Field. M. Didlaukis. *Zeits. f. Physik*, 74. 9–10. *pp.* 624–630, *March* 3, 1932.—It is assumed that the free path of the electrons is independent of their velocity and the collisions with gas molecules are taken to be elastic. The velocity distribution of the electrons in a uniform electric field is evaluated by a simplified method, and differs from the Maxwellian distribution in showing a greater concentration of electrons having energy in the neighbourhood of the most probable energy value. The distribution derived by Druyvesteyn for the present problem is intermediate in character between the Maxwellian distribution and that given here. W. S. S.

2982. Collision of Electrons with Molecules. H. S. W. Massey and C. B. O. Mohr. *Roy. Soc., Proc.* 135. *pp.* 258–275, *Feb.* 1, 1932.—Born's theory of collisions as modified by Oppenheimer is applied to several phenomena involving the impact of electrons with molecules. Elastic collisions within the range of the validity of Born's formula are first considered. The scattered intensity due to a number of axially symmetric fields with random orientation is shown to be a function of the product of the velocity and the sine of half the angle of scattering. A simple formula is found relating electron and X-ray scattering. The case of molecular H is treated in detail, and the intensity of elastic scattering calculated for all angles and velocities for which the Born formula is valid. Inelastic collisions are next considered, and the importance of the Franck–Condon principle discussed. The latter implies the diffraction of electrons which have excited a particular electronic state of the molecule. This is illustrated by considering the probability of excitation of the B state of H. Finally, the probability of dissociation of the molecule with two atoms in the ground state is calculated, using Oppenheimer's theory. J. J. S.

2983. Polarisation of Electrons by Double Scattering. N. F. Mott. *Roy. Soc., Proc.* 135. *pp.* 429–458, *March* 1, 1932.—Refers to the author's previous paper [see Abstract 3254 (1929)] on the subject. It was then found that with single nuclear scattering, using thin foils as scattering targets, a polarisation effect is to be expected when a beam is scattered by two successive targets. Taking the case in which the electron is scattered at right angles to its original direction by the first target, T_1, and at right angles to its new direction by the second target, T_2, the number scattered in a direction T_2M is proportional to $1 + \delta \cos \phi$, where δ is a positive constant, and ϕ is the angle between the original and the final plane in which the electron moves. The main object of the present paper is to obtain numerical values for δ, for various values of v/c, without making any approximation. The calculations are carried out for gold ($z = 79$), and for scattering angles of 90°. Values are also obtained for the total scattered intensity under these circumstances. Several points concerning the spin of the electron are discussed, and in particular whether it is possible to obtain a beam of polarised electrons by any other method. The scattering of a beam of electrons by a central field is dealt with, and the greater part of the paper is devoted to the special problem of scattering by the inverse square law. The numerical results obtained are illustrated by means of graphs. H. N. A.

2984. Reflection of Kathode Rays by Bent Molybdenite. T. Yamaguti. *Phys. Math. Soc., Japan, Proc.* 14. *pp.* 57–62, *Feb.*, 1932. *In English.*—From a detailed investigation of reflecting spectra of kathode rays of 14–61 kV from bent molybdenite, the inner potential, the refractive indices for kathode rays and the parameter specifying the atomic arrangement in the crystal were determined. The inner potential was found to be 16·5 volts independent of electron velocity. The interval in which the parameter lies was more accurately determined than that already obtained by the X-ray method. It was found that by the ordinary transmission method *N*-patterns of molybdenite can be obtained and be used for the calibration of the wave-length of kathode rays. [See Abstract 606 (1931).] AUTHOR.

2985. Scattering of Slow Kathode Rays in Single Crystals. F. Kirchner. *Zeits. f. Physik*, 13. 1. *pp.* 38–58, *March* 26, 1932.—Decrease of intensity of a beam of kathode rays due to passage through a crystal of mica is attributed to interference scattering. The dependence of the decrease of intensity upon the thickness of crystal and the velocity of the rays is measured. For a velocity corresponding to 50 kV, the intensity of the most marked interference shown by the beam after traversing a thickness 10^{-5} cm. of the crystal amounts to about 1 %; under the same conditions the continuous background shows a decrease of intensity of only about 0·01 %. The width of the interference band is in agreement with theoretical deductions from a kinematic theory of space-lattice interference, but this theory is not applicable to the discussion of the intensity of interference associated with crystals of the thickness entering into the present work. J. S. G. T.

2986. Electron Diffraction with Pure and Passive Iron. W. Boas and E. Rupp. *Ann. d. Physik*, 13. 1. *pp.* 1–8, *March* 26, 1932.—Electron diffraction at the [110] face of a single crystal of iron gives a set of maxima which may be correlated if it is assumed that there is an inner potential of 14 ± 1 volts, which is independent of the voltage of the electrons. At the 3rd order, anomalous dispersion, of the type described by Davisson and Germer [see Abstract 270 (1929)], appears at 150 volts. For passive iron an additional 12 maxima have been identified in addition to the five already known. The lattice parameter of the passive layer is 2·94 Å. if the inner potential is zero, and 3·33 Å. if the inner potential is 14 volts, that of pure iron. F. J. W.

2987. Interpretation of Half-Number Interference in Electron Diffraction. E. Rupp. *Ann. d. Physik*, 13. 1. *pp.* 101–110, *March* 26, 1932.—In electron difiraction by crystals cases of forbidden and half-integral orders of interference are known. By considering the possible cases of reflection by a crystal lattice, combining surface reflections with internal ones, and assuming only integral orders of interference, it appears possible to account for the half-integral reflections observed. The simultaneous occurrence of reflections indicating an internal potential $E_0 = 0$ and $E_0 \neq 0$ is explained on the same basis. The theory is illustrated and supported by measurements with crystals of zinc. N. D.

2988. Emission of Secondary Electrons by Nickel and Relation to Ferromagnetism. P. Tartakowsky and W. Kudrjawzewa. *Zeits. f. Physik*, 75. 1–2. *pp.* 137–142, *March* 17, 1932.—Certain properties are studied of the secondary electrons emitted by nickel on which a beam of

primary electrons is falling, *viz.*, the intensity of the secondary current as a function of the primary velocity, the velocity distribution in the secondary beam and the dependence of these quantities upon temperature. At the Curie point, 358° C., the secondary emission shows a sudden rise. Hence it is supposed that the secondary electrons are connected with the ferromagnetism of nickel. This property is not shown by copper. If the secondary electrons are identifiable with the conductivity electrons, the latter must be responsible for the ferromagnetic properties. N. D.

2989. Secondary Effects following the Primary Photoelectric Effect of Cæsium Atoms Adsorbed in Salt Films. J. H. de Boer and M. C. Teves. *Zeits. f. Physik*, 74. 9–10, *pp.* 604–623, *March* 3, 1932.—The photoelectric emission from salt layers (CaF_2, BaF_2, Cs_2O) containing adsorbed cæsium atoms is hindered in the case of thick layers by the difficulty with which electrons are supplied to neutralise the cæsium ions formed in the primary-emission process. The electron supply is improved by making the salt layer photoelectrically conducting by introducing alkali atoms into the space lattice. This can be accomplished by heating in alkali vapour, and is facilitated if the space lattice is previously distorted by the introduction of foreign atoms (tungsten, silver). With thick (100 molecules) Cs_2O–Cs layers prepared in this way, photokathodes giving a saturated current at about 50 volts and a total light sensitivity up to 200×10^{-6} ampere/lumen (2680° K.) have been obtained. Such cells, however, show a fatigue effect as the photoelectrically conducting Cs_2O–Cs layer passes into an activated state, and the electron supply is impaired. A detailed investigation is described, of the relation between the fatigue effect, the temperature, wave-length of incident light, applied voltage, etc. A physical picture of the mechanism of the fatigue effect is developed. W. S. S.

2990. Photo-Ionisation Probabilities of Atomic Potassium. Melba Phillips. *Phys. Rev.* 39. *pp.* 905–912, *March* 15, 1932.—The absorption probabilities in the continuous spectrum of a potassium atom are calculated in order to determine whether the second maximum in the experimental photo-ionisation curve is of atomic origin. The K atom is assumed to be a single normal state valency electron moving in a non-Coulomb central force field. Two fields were used. The first was determined to satisfy the quantum conditions governing the radial phase integrals for the X-ray and optical levels (Zwaan's method.) The second was Hartree's self-consistent field for the K atom, corrected for polarisation of the core to give the observed term values for the normal state and 3_3 orbits as proper values of the wave equation. The matrix integrals for transition probabilities were determined graphically and the wave functions by numerical integration. The curve of probabilities obtained does not show a second maximum, and no reasonable changes in the field appear to produce such a variation. N. D.

2991. Dependence of the Photoelectric Emission of Potassium on the Arrangement of Layers of Hydrogen and Potassium Atoms on the Surface. P. I. Lukirsky and S. Rijanoff. *Zeits. f. Physik*, 75. 3–4. *pp.* 249–257, *March* 31, 1932.—Experimental results are given in support of Fowler's hypothesis that the hydrogen atoms can occupy two positions, either above or below the first potassium layer. The latter arrangement produces the maximum photoelectric effect, while the double

hydrogen layer, potassium –H–K–H–K also gives intense results. On the other hand, a single outer layer of hydrogen, or the arrangement potassium –H–K–H–K–H, produces a diminution of the effect. If the potassium layer is more than one atom thick the photoelectric emission obtained is the same as for pure potassium. C. B. A.

2992. Spectral Distribution of the Depolarisation Current in the Photoelectric Conductivity of Rock-Salt Irradiated with X-Rays. N. Kalabuchow and B. Fischelew. *Zeits. f. Physik*, 75. 3–4. *pp.* 282–286, *March* 31, 1932.—Two maxima in the photoelectric depolarisation current are found for rock-salt previously treated with X-rays when it is irradiated with light of wave-lengths 4550 Å. and 4700 Å. It is concluded that the electrons forming the negative space charge during the polarisation process are less strongly bound than in the sodium atom. C. B. A.

2993. Electron Stream Produced by Light. H. Dember. *Phys. Zeits.* 33. *pp.* 207–208, *March* 1, 1932.—When light impinges on semi-conductors a forward stream of electrons is produced [see Abstract 4297 (1931)]. These experiments were designed to remove an objection lodged against the effect by Schottky that it was due to contact potentials. The metal electrodes were, in these experiments with Cu_2O, separated from the material by mica sheets. When light falls on the Cu_2O a unidirectional p.d. of 0·02 volts, as measured by a Lindemann electrometer, is set up. J. E.

2994. Photoelectric Effect in Semi-Conductors. L. Bergmann. *Phys. Zeits.* 33. *pp.* 209–213, *March* 1, 1932.—A metal plate coated with gray selenium, copper oxide, or other sensitive substance, is placed in the grid circuit of the first valve of an amplifier and is illuminated with intermittent light. A note of the same frequency as the light is heard in the telephone. When a wire gauze, connected to the filament of the same valve, is placed in front of the sensitive layer the loudness of the note is increased even if a glass or mica plate covers the layer. The construction of a special cell to investigate this effect more fully is described in detail. As the intensity of the light is increased a saturation value of the current in the amplifier is reached. These effects are ascribed to a cloud of electrons, released by the light, moving to and fro between the plates of the cell, which forms a condenser. Other cells are described in which both faces of a layer of active substance can be exposed to light. In others the substance is split into two parts by a sheet of metal foil or black paper, which forms a separate electrode. Various results are recorded. N. D.

2995. Effect of Surface Changes on the Photoelectric Emission of Silver and Gold. T. E. Clarke. *Phil. Mag.* 13. *pp.* 624–632, *March*, 1932.—The unaccelerated emission and also the saturation current have been measured for polished and for annealed surfaces of the two metals. The differences in the results are attributed to changes in the adsorbed gas layer. J. H. A.

2996. Surface Electrons. J. E. Nyrop. *Phys. Rev.* 39. *pp.* 967–976, *March* 15, 1932.—The theory regarding the degenerate electronic gas inside an electron-conductor producing an electronic gas, *i.e.*, the surface-electrons, covering the surface of the conductor is applied to the ordinary and the selective photoelectric effect and the evaporation from heated metals. Further, it is explained how the adsorption caused by metallic surfaces and the catalytic effect produced by them can be calculated when

surface-electrons are considered, and that the potential barrier which accounts for the work function also can be estimated. AUTHOR.

2997. Theory of Rapidly Vibrating Charges. G. Beck. *Zeits. f. Physik*, 75. 3-4. *pp.* 211–222, *March* 31, 1932.—A model of a relativistic linear oscillator is considered mathematically and its damping factor is calculated. In the expression for the latter the frequency is present in its first power, whereas in the classical damping factor it appears in its second. This result, though derived from one-dimensional theory, is applied to the problem of the behaviour of the three-dimensional nuclear electrons. It gives qualitative information about the origin of the hard beryllium radiation (Chadwick's neutron radiation), the packing energies of nuclei, and the anomalous absorption of hard γ-rays by heavy nuclei.
N. D.

2998. New Method for Absorption Measurements in Pure Liquids and Electrolyte Solutions in the Region of Short Electric Waves. J. Malsch. *Ann. d. Physik*, 12. 7. *pp.* 865–888, *March* 4, 1932.—A simple arrangement is described for the direct measurement of h.f. heating in liquids, various alcohols (methyl, ethyl, *n*-propyl and *n*-butyl) being taken for wave-lengths of 76 m., 48 m. and 28 m. The data show very good quantitative agreement with the Debye dipole-formulæ. The application of the method for the absolute measurement of the h.f. conductivity of electrolyte solutions is discussed for the cases of silver nitrate and ferric chloride in ethyl alcohol, and agreement found with the Debye–Falkenhagen theory. [See Abstract 2073 (1932).] H. H. Ho.

2999. Diamagnetic Susceptibilities of Inorganic Compounds. Part I. Acids, Alkali and Alkali-Earth Salts. K. Kido. *Tohoku Univ., Sci. Reports*, 21. *pp.* 149–170, *March*, 1932. *In English.*—A method for measuring the magnetic susceptibility of the inorganic compounds similar in principle to that of Weiss and Föex was used. The susceptibilities of the compounds, including halides, nitrates, hydroxides, carbonates, sulphates, acetates of alkali and alkali-earth groups and some acids, were measured. Assuming an additive law of diamagnetic susceptibility, the ionic susceptibilities of ions were derived. The following results given in ionic susceptibility χ ($\times -10^{-6}$) were obtained: $F^- = 12{\cdot}2$, $Cl^- = 22{\cdot}1$, $Br^- = 34{\cdot}7$, $I^- = 53{\cdot}2$, $Li^+ = 1{\cdot}6$, $Na^+ 7{\cdot}6$, $K^+ = 13{\cdot}6$, $Be^{++} = -0{\cdot}1$, $Mg^{++} = 4{\cdot}3$, $Ca^{++} = 6{\cdot}5$, Sr^{++} $15{\cdot}6$, $Ba^{++} = 23{\cdot}6$, $NH_4^+ = 12{\cdot}4$, $NO_3^- = 20{\cdot}1$, $OH^- = 8{\cdot}5$, $SO_4^{--} = 39{\cdot}0$, $CO_3^{--} = 28{\cdot}1$, $CH_3CO_2^- = 32$. These ionic susceptibilities are approximately represented by a relation, $-\chi_{ion} = cn\,10^{-6}$, where n is the number of electrons in ions and c a constant, the value of which is 0·98 for halogen ions, 0·80 for alkali ions, 0·45 for alkali-earth ions respectively. AUTHOR.

3000. Magnetic Saturation. E. Czerlinsky. *Ann. d. Physik*, 13. 1. *pp.* 80–100, *March* 26, 1932.—An investigation of the Weber statement that when ferromagnetic materials are already saturated in a very high magnetic field there is simultaneously a diamagnetic susceptibility which evinces itself and is measurable. The original idea of the present paper was to measure and identify the order of this diamagnetism. Permalloy was selected for experiment, since it is saturated in comparatively low fields. An attempt was made by increasing the magnetisation, to decrease the ferromagnetic susceptibility. The effect is duly noted and

discussed. Apparently the magnetising coil contained more lines of force than the sample of permalloy, as the field strength was raised above saturation. A full theoretical discussion into practical details and tables of results is appended. S. G. B.

3001. Ferromagnetism and Electrical Characteristics. Part IV. Discussion. W. Gerlach. *Ann. d. Physik*, 12. 7. *pp.* 849–864, *March* 4, 1932.—In the previous section [see Abstracts 985, 2800 (1931), and 1387 (1932)] it has been shown that the alteration of resistance of ferromagnetic conductors exhibits two opposite and completely different phenomena, namely, an increase and a decrease of resistance. The first corresponds to certain phenomena of ferromagnetic bodies below the Curie point, whilst the second is influenced by the internal or spontaneous magnetisation. The present work shows that above the Curie point nickel exhibits a decrease of resistance proportional to the square of the magnetisation and also to the internal magnetic energy. In the ferromagnetic range the increase of resistance is proportional to $(J^2 - J_0^2)$, and reaches saturation with the magnetisation. The increase of resistance is connected with the rotational process of magnetisation. This hypothesis is founded upon measurements of alterations of resistance and its hysteresis under extreme conditions. For strongly drawn nickel the relationship $\Delta R = CJ^2$ is apparently valid. S. G. B.

3002. Law Regarding the Discontinuity of Magnetic Properties at the Curie Points. R. Forrer. *Comptes Rendus*, 194. *pp.* 697–699, *Feb.* 22, *and pp.* 779–781, *Feb.* 29, 1932.—The author extends his previous hypothesis regarding the existence of "magnetic multiplets," and seeks to determine their function and position in relation to the normal lattice. He further postulates that the magnetic multiplets in their normal position in the lattice results from the existence of fixed electronic orbits in the material surrounding the atom, *i.e.*, external to the atom. The electronic multiplets have a double rôle: (1) they undergo an influence from the symmetry of the lattice, and (2) they impose, to a certain degree, an influence upon the magnetic multiplet. If the diameter of the electronic orbits equal the distance between the centres of the atoms in the plane under consideration, then these electronic multiplet orbits touch each other. These contacts are called "effective contacts," and it is made a fundamental hypothesis that they are essential for the production of ferromagnetism. The present work seeks to establish their relationship to the molecular field by means of the phenomena at the Curie points. The number "N" of the "effective contacts" is defined as the product of the number of orbits (n) of the electronic multiplet and the number of contacts (p) of one orbit with the orbits of its neighbours. Thus for iron, in a plane perpendicular to the axis, an orbit ($n = 3$) has four contacts ($p = 4$), and therefore $N = 12$. For Ni, $N = 4$, and for cobalt, $N = 24$. These numbers, N (4 for Ni, 12 for Fe and 24 for CO) are in the same order as their Curie points θ, and the relationship $\theta = T_1\sqrt{N}$ is proposed, where T_1 is the temperature for a single efficiency contact, *i.e.*, $N = 1$. The values of N and T_1 are then calculated for a number of substances, and the results set out in tabular form. The second part of the paper consists of argument and verifications in support of the above law, and reference is made to the proposals of Heisenberg and Heitler in comparison with the present work. S. G. B.

3003. Alteration of Resistance and Magnetisation at the Curie Point. E. Englert. *Zeits. f. Physik*, 74. 11–12. *pp.* 748–756, *March* 11, 1932.—The diminution of resistance and magnetisation of nickel at the Curie point have been measured. The relation $-\Delta R = B(t)(J^2 - J_0^2)$ holds. Above the Curie point $J_0 = 0$, at the same time $B(t)$ is a linear function of the temperature in the measured temperature interval. There is a close connection between the diminution of resistance at the Curie point and that due to spontaneous magnetisation at lower temperatures. H. N. A.

3004. Gyromagnetic Ratio for Paramagnetic Substances. Part III. Salts of the Rare Earth Group. W. Sucksmith. *Roy. Soc., Proc.* 135. *pp.* 276–281, *Feb.* 1, 1932.—In two previous papers [see Abstract 592 (1932)] a description was given of an apparatus for the measurement of the gyromagnetic ratio for paramagnetic substances, together with results on some salts of the iron group. In the present paper an account is given of the extension of the measurements to some paramagnetic substances in the rare earth group. The mean value of g, the Landé splitting factor, for different ions is found to be in agreement with the modification of the Hund theory of paramagnetism as modified by van Vleck. For the ions Gd^{+++}, Nd^{+++}, Eu^{+++} and Dy^{+++} the theoretical values are $g = 2{\cdot}0$, $0{\cdot}75$, $6{\cdot}4$ and $1{\cdot}33$, whereas experiment gives $2{\cdot}12$, $0{\cdot}78$, $> 4{\cdot}5$ and $1{\cdot}36$ respectively. J. J. S.

3005. Electromagnetic Field Produced by A.C. in a Wire. Dubourdieu. *Comptes Rendus*, 194. *pp.* 848–850, *March* 7, 1932.—A mathematical discussion is given of the case of an electromagnetic field produced by a wire conveying a sinusoidal a.c. above a conducting sheet. J. J. S.

3006. Symbolic Calculus. B. van der Pol and K. F. Niessen. *Phil. Mag.* 13. *pp.* 537–577, *March*, 1932.—The fundamental rules and results contained in a previous paper on this subject by van der Pol [see Abstract 2005 (1930)], in which the operational calculus of Heaviside in the form due to Carson is applied to the solution of ordinary differential equations with either constant or variable coefficients, are briefly reviewed and extended to deduce a number of new relations derived, *e.g.*, from Laguerre and Hermite polynomials, Bessel and Beta functions and to evaluate certain definite integrals. J. S. G. T.

3007. Equations of Laplace and Maxwell. K. F. Herzfeld. *Phys. Rev.* 39. *pp.* 497–503, *Feb.* 1, 1932.—An attempt is made to deduce the equations of electrostatics and of electrodynamics from general axioms instead of quantitative experiments. Among the axioms necessary to find the first are: the existence of a field, determined by differential equations without action at a distance, the principle of superposition, isotropy of space and existence of a potential. From Poisson's equation Maxwell's equations follow with four additional assumptions, the chief of which is the validity of the restricted theory of relativity. AUTHOR.

3008. Orientated Atoms in a Variable Magnetic Field. E. Majorana. *N. Cimento*, 9. *pp.* 43–50, *Feb.*, 1932.—The author considers a pencil of orientated atoms (*e.g.*, one of the rays obtained from a Stern–Gerlach experiment) which is made to pass near to a point at which the magnetic field is zero. Initially the atoms are supposed to lie with their

magnetic moments parallel to and in the same sense as the field in their immediate neighbourhood. After passing near the field point of zero intensity, however, the field in the vicinity of the atoms will have swung round into the reverse direction, and the question is whether all the atoms will have swung round in like manner (adiabatic process), or whether non-adiabatic processes occur. The calculation shows that there is a non-zero probability that an atom will end up with its magnetic moment in the opposite direction to the field, as the result of a non-adiabatic process, *i.e.*, a quantum transition. The probability in question is obtained in terms of the gradient of the field and its magnitude, at the point of closest approach of the atoms to the position of zero field. W. S. S.

3009. New Determination of e/m from the Zeeman Effect. J. S. Campbell and W. V. Houston. *Phys. Rev.* 39. *pp.* 601–615, *Feb.* 15, 1932.—Values of *e/m* have been determined from the Zeeman separations of the Cd line 6439 and the Zn line 6362. For these lines the *g*-factors can be accurately determined from the theory. A magnetic field of 7300 gauss was produced by an air-core solenoid in which the variation of field strength over a length of 6 cm. at the centre was less than 0·1 %. The field to current ratio K of this solenoid was determined in terms of the calculated ratios of three single-layer standard solenoids. The field strength during an exposure was then given by the product of this constant and the current flowing. Evaporation of Zn and Cd in the short (6 cm.) positive column of a helium discharge tube gave the desired lines. The Zeeman patterns were photographed with a Fabry–Pérot interferometer. The result is $e/m = 1{\cdot}7579 \pm 0{\cdot}0025 \times 10^7$ e.m.u. per gm. AUTHORS.

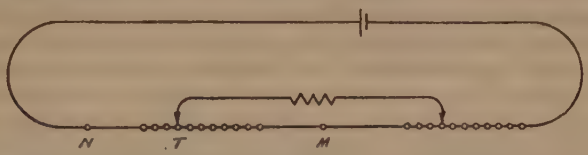
3010. Electrons, Protons and Electromagnetism. A. Günther-schulze. *Zeits. f. Physik*, 74. 9–10. *pp.* 692–706, *March* 3, 1932.—If the material world is built of protons and electrons it must be possible to deduce the laws of electromagnetism solely from considerations of the relative actions of protons on protons, protons on electrons and electrons on electrons, these being deduced from Coulomb's law. The paper concerns itself with the derivation of several electromagnetic properties on these lines. Thus, the mutual interaction of parallel currents in both straight and curved conductors are deduced, the induced voltage produced in a conductor when the current is varied (electromagnetic induction) is calculated, and Maxwell's equations are established. G. E. B.

3011. Energy of Matter. E. Sevin. *Comptes Rendus*, 194. *pp.* 1116–1119, *March* 29, 1932.—The author starts with the classical electromagnetic relations for the energy of the electrostatic field of the particle and obtains expressions for the total energy of the particle when at rest, its potential energy when oscillating about the position of equilibrium and the constant of fine structure. The results confirm the experimental results of Bond and Birge. [See also Abstract 602 (1932).] R. S. R.

APPARATUS AND INSTRUMENTS.

3012. Wenner Potentiometer. L. Behr. *Rev. Sci. Instruments*, 3. *pp.* 109–120, *March*, 1932.—The Wenner potentiometer is of the decade design, so constructed that e.m.f.s and resistances at the contacts are largely eliminated. The present paper describes the details of a five-dial potentiometer having two ranges, one of 1·9111 volts in steps of 10 μV, and the other of 0·19111 volts. The effect of contact e.m.f.s, etc., is considered

in detail. The limit of accuracy of the instrument is claimed to be 2 μV for the high range, and 0·2 μV for the low range. The principle of the Wenner design is shown in the fig., which illustrates diagrammatically the construction of one decade. By means of a double-dial switch both branch points between the shunt (of relatively high resistance) and the main circuit



may be shifted in steps of equal resistance so as to introduce more or less resistance between T and N, while keeping the resistance shunted constant. The movement of the switch produces a change in the p.d. between M and N equal to the product of the current in the shunt and the change in resistance between T and N. G. E. B.

3013. Method of Measuring a Small Capacitance. R. Barton. *Rev. Sci. Instruments*, 3. *pp.* 123–132, *March*, 1932.—A modification of the method whereby the small condenser is alternately charged from a larger condenser and discharged, in which the potential of the large condenser is restored between charges to its initial value. This is accomplished by using a variable condenser, and reducing its capacity each time. The capacity of the small condenser is deduced from the necessary change in the capacity of the larger one. The theory of the method is given. G. E. B.

3014. Concentration Coil as a Magnifying Lens. F. Hamacher. *Arch. f. Elektrot.* 26. *pp.* 215–218, *March* 22, 1932.—By means of fluorescent-screen photographs it is shown that the non-homogeneity of the field of a coil may be utilised to enlarge the cross-sectional measurements of an electron beam. Photographs are reproduced of the effects obtained when using a tungsten filament as the source. A. W.

3015. Kathode-Ray Oscillographic Method of Measuring Inductance. G. I. Finch and R. W. Sutton. *Phys. Soc., Proc.* 44. *pp.* 190–193; *Disc.*, 193–194, *March*, 1932.—The voltage fluctuations across the condenser in a damped oscillatory circuit, comprising inductance, capacity and resistance, are recorded by means of a kathode-ray oscillograph. The following relationship is derived:

$$L = CV_1^2\{1 + \lambda + (\tfrac{1}{2} + 2/\pi^2)\lambda^2 + (\tfrac{1}{6} + 2/\pi^2)\lambda^3\}/i_0^2,$$

where L is the inductance, C the capacity, V_1 the first peak voltage across C in a train of damped oscillations, i_0 the primary current through L at break of a charging circuit and λ the logarithmic decrement of the oscillatory circuit. The measurement of V and λ from the oscillogram is discussed.

AUTHORS.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

3016. Effect of Ultra-Violet Radiation on the Eye. M. Luckiesh. *El. World*, 99. *p.* 583, *March* 26, 1932.—A brief summary of existing knowledge. The physiological effect of ultra-violet light on the eye obeys the reciprocity law, and the effects of intermittent exposure are additive if the period of intermittency is less than 24 hours. Ultra-violet light produces erythema and conjunctivitis, and it has been shown that these are due

mainly to wave-lengths less than about 2800 Å. It is suggested that, except in special cases, sources of ultra-violet light should be prevented from emitting wave-lengths less than 2800 Å. G. E. B.

3017. Variation of Total X-Ray Energy With Potential. W. Moppett. *Brit. J. of Radiology*, 5. *pp.* 250–251, *March*, 1932.—Experiments carried out to confirm that, within the range of hard radiation used in radio-therapy, the total X-ray energy varies as the square of the exciting potential. The apparatus used has been previously described and employed a bismuth-copper thermocouple. Radiation was provided by a deep-therapy electron tube and a constant potential generator. Voltages were measured by means of a sphere gap. The tube current was 3 mA between 90 and 150 kV in one series and 6 to 9 mA, divided by two and three to allow comparison, in another series of experiments. The law is confirmed. Characteristic radiation of the K level of bismuth was found to have a marked effect, but the K radiation of the tungsten tube target was found to have little effect. B. J. L.

3018. Experimental Radiography Utilising the γ-Rays of Radium. C. G. Osment. *Brit. J. of Radiology*, 5. *pp.* 269–274; *Disc.*, 274, *March*, 1932.—Discusses the use of radium instead of X-rays for radiography of metallic castings, etc., in industry. Radium salt or radium emanation can be utilised, but, for the use of radon, as much as 1 gm. of radium salt may be necessary. The quantity of radium required depends upon the thickness of the objects of examination, their number and the time of exposure desired. The advantages and disadvantages of X-rays, as compared with radium, in metallurgical work, are summarised. Sample radiographs are then shown and described, although the author does not consider these examples as perhaps the best obtainable by the radium method. In the *Discussion*, **V. E. Pullin** commented upon and showed slides of similar work carried out at the Royal Arsenal research department. B. J. L.

3019. Voltage-Frequency Relationships in Action Currents. L. E. Travis and T. A. Hunter. *Science*, 75. *pp.* 220–221, *Feb.* 19, 1932.—In electrophysiological investigations it is usual to record frequency, amplitudes and phase angles photographically. Frequency is obtained by measurement of the time interval between successive peaks of a wave train. This method is inaccurate, and wave analysis by means of a Fourier series is not possible. The authors propose a new method depending upon the determination of the total voltage within a certain frequency band. The frequency–intensity–phase angle relationships are thus resolved into a common denominator, voltage which, for practical purposes, may be thought of as power. Power equals the voltage squared divided by resistance, and as the latter can be held constant the voltage may be read as a direct expression of power. This unit of analysis is not only accurate but practical. The actual method involves the use of two 3-stage amplifiers, and the apparatus utilised is briefly described. Examples of voltage-frequency curves so obtained are given, and these, in general shape, resemble a probability curve. The authors conclude that the current wave is a very complex one composed of direct, pulsating and alternating currents having no direct relationship with respect to phase or time, and therefore not harmonic. The method has yet to be tested in actual electrophysiological problems. B. J. L.

CHEMICAL PHYSICS AND ELECTROCHEMISTRY.

3020. Discontinuity of the Isothermals for the Adsorption of Phenol from Solution. R. Chaplin. *J. Phys. Chem.* 36. *pp.* 909–912, *March*, 1932.—The adsorption isothermals of phenol from aqueous solution on a technical active charcoal have been determined at 25° and 60° at concentrations between 0·1 and 24·0 gm./l. The isotherms show pronounced discontinuity. F. J. W.

3021. Sorption of Water Vapour by Cellulose and its Derivatives. Part III. Heat of Adsorption of Water Vapour by Cellulose Acetates. P. T. Newsome and S. E. Sheppard. *J. Phys. Chem.* 36. *pp.* 930–938, *March*, 1932. *Comm. No.* 483 *from the Kodak Research Lab.*—Moisture adsorption isotherms of a sample of cellulose film base (39 % acetyl) 0·005 in. in thickness at 30°, 40° and 50° [see Abstract 292 (1931)] are plotted as a function of the relative vapour pressure, p : P. Calculation of the total heat of adsorption per gm. of adsorbed vapour from pairs of these isotherms [see Hedges, Abstract 228 (1927)] gives $Q = 2411(\log p_2 - \log p_1)$ at 30°–40° and $2570(\log p_2 - \log p_1)$ at 40°–50°, p_2 and p_1 being the equilibrium pressures at the temperatures at which the adsorbent contains the same amount of adsorbed vapour. The heat of adsorption is greatest for the first small amounts of adsorbed water and then rapidly decreases to values not far above the heats of condensation, *viz.*, 577 cal. at 35° and 572 cal. at 45°. The values determined experimentally are much lower than these calculated values but they also appear to approach the heat of condensation of water as the initial moisture content increases. The total heat liberated in the adsorption of moisture by cellulose triacetate is less than that liberated in the adsorption of the same amount of water by the diacetate and is also nearer to the capillary condensation curve. This supports the view, previously deduced [see Abstract 292 (1931)], that there are two main factors influencing the adsorption of water. T. H. P.

3022. Adsorption of Gases by Electrolytic Iron. F. Durau and C. H. Teckentrup. *Ann. d. Physik*, 12. 8. *pp.* 927–960, *March* 10, 1932. —The adsorption of gases by electrolytic iron which has been fused *in vacuo* was studied at 18° C. by a volumetric method. The iron was prepared in powder form in a specially designed apparatus which allowed the material to be prepared in an atmosphere of nitrogen. The gases were A, H_2, N_2, O_2, CO, CO_2, C_2N_2, NO, N_2O, SO_2, NH_3, HCl, CH_4, C_2H_6, C_3H_8, C_2H_4, C_3H_6 and CH_4Cl. The results render it probable that monomolecular adsorbed layers are formed. F. J. B.

3023. Apparent Volumes of Salts in Solutions. Part III. Saturated Solutions of Mixed Electrolytes. A. F. Scott. *J. Phys. Chem.* 36. *pp.* 1022 1034, *March*, 1932. –The present paper refers to apparent molal volumes of salts in saturated solutions of mixed electrolytes. A simple method is described for the analysis of the experimental data obtained. It is held that if the added electrolyte has a kation in common with the saturating salt, its apparent volume is the same as when it is the saturated salt, but if the added electrolyte has an anion in common with the saturating salt, its apparent volume has a unique but constant value. Potassium nitrate is an exception to these rules. [For Parts I and II see Abstracts 4326 (1931) and 1774 (1932).] J. K.

3024. Photometric Determination of the Solubility of Silver and Mercurous Chloride. W. G. Eversole and R. W. McLachlan. *Am. Chem. Soc., J.* 54. *pp.* 864–869, *March*, 1932.—The solubility of sparingly soluble salts was determined by an improved method, in which a modified Tyndall meter and a gradation photometer were employed. The solubility of silver chloride in five concentrations of nitric acid and in water containing potassium and nitrate ions from reactants which produce silver chloride was measured at 25° C. The solubility was found to vary from $1{\cdot}43 \times 10^{-5}$ in $0{\cdot}0024\ N$ nitric acid to $2{\cdot}37 \times 10^{-5}$ in $0{\cdot}524\ N$ nitric acid. The solubility of mercurous nitrate was found to vary from $4{\cdot}7 \times 10^{-6}$ molecules per litre in $0{\cdot}0005\ N$ perchloric acid to $6{\cdot}3 \times 10^{-6}$ in $0{\cdot}200\ N$ perchloric acid, and from $5{\cdot}2 \times 10^{-6}$ in $0{\cdot}005\ N$ nitric acid to $5{\cdot}8 \times 10^{-6}$ in $0{\cdot}100\ N$ nitric acid. The sensitiveness of the method is of the order of 10^{-7} molecules per litre. F. J. B.

3025. Solubilities of Copper, Manganese and Some Sparingly Soluble Metals in Mercury. N. M. Irvin and A. S. Russell. *Chem. Soc., J. pp.* 891–898, *March*, 1932.—The solubilities of metals of atomic numbers 22–29 and of molybdenum, tungsten and uranium in mercury at 20° C. have been measured. Copper and manganese alone have solubilities greater than 1 in 10^7, their values being 0·0020 % and 0·0010 % respectively. The upper limits for the solubilities of the other metals are given. F. J. W.

3026. Permeability of a Membrane. P. Reiss. *Comptes Rendus*, 194. *pp.* 970–972, *March* 14, 1932.—A collodion film containing water is permeable on the one hand to strong aqueous reducing solutions, and on the other hand to various oxidation-reduction colours such as Nile-blue, cresyl-blue and phenosaffranine. If the colours and the reducing solutions are present simultaneously, this permeability presents notable modifications. Thus, when one of two adjoining compartments is filled with distilled water and the other with a solution of titanium chloride, and the membrane is coloured with nigrosine, the p.d. remains constant at 650 mV for three days. On the fourth day it becomes 550 mV, and the sixth day 25 mV. At the same time, the titanium chloride solution loses its reducing power. The blockage of the permeability for strong reducers appears to be connected with the presence in the membrane of a body of reversible oxidation-reduction equilibrium. This is a new example of the intervention of electrical factors in the permeability of a membrane. E. E. F. d'A.

3027. Coordination of Periodic Structures. M. Copisarow. *J. Phys. Chem.* 36. *pp.* 752–759, *Feb.*, 1932.—Banded or spiral formations have been obtained when deposits occurred in a long (60 in.) tube: (*a*) of solid CO_2 when CO_2 gas under high pressure was admitted into the cooled tube; (*b*) of ammonium carbonate or carbamate from the volatilised material; (*c*) of the carbamate when NH_3 and CO_2 were admitted at opposite ends; and (*d*) of MgO from Mg burnt at one end. The results are compared with Liesegang rings and other similar formations. C. A. S.

3028. Particle Size of Colloidal Hydrous Beryllium Oxide Sols. W. H. Madson. *J. Phys. Chem.* 36. *pp.* 855–859, *March*, 1932.—It is shown that the particle size in connection with four colloidal hydrous beryllium oxide sols ranges from $147\ \mu\mu$ to $160\ \mu\mu$, the mean size being $153{\cdot}5\ \mu\mu$ for the cube edge. J. K.

3029. Hydration or Combined Water of Gelatin. T. Moran. *Roy. Soc., Proc.* 135. *pp.* 411–428, *March* 1, 1932.—In a previous paper [see Abstract 231 (1927)] the author has shown that when gelatin gel is frozen so that pure ice separates, the concentration of the gel in equilibrium with ice is a function of the temperature. In the present communication this temperature-concentration curve is analysed in an attempt to fix the hydration or combined water of gelatin. It is shown that at about $-20°$ C. and below the concentration is constant and the water in the gel is approximately 0·5 gm. per gram of gelatin. The effects of sodium chloride, potassium chloride, sodium nitrate, ammonium sulphate and sucrose are determined. J. K.

3030. Energies of Immersion of Silica in a Series of Liquids. F. E. Bartell and E. G. Almy. *J. Phys. Chem.* 36. *pp.* 985–999, *March*, 1932.—Methods of determining the change in free surface energy when a solid-air interface is replaced by a liquid-air interface are briefly discussed, and the literature dealing with attempts to relate heats of wetting to total surface energy changes is surveyed. The heats of wetting of one silica gel by a series of liquids stand in the same ratios to each other as those of any other silica gel by the same liquid; this holds for gels varying in method of preparation, in physical properties (such as hardness), in water content and in activity. It is hence deduced that, even though it is known that silica gel contains small proportions of water, the heats of wetting of a gel by a series of liquids have the same relative values as the total energies of immersion of dry silica in the same liquids. The theoretical equation relating adhesion tension to heat of wetting is discussed with especial attention to the approximations involved and the probable extent of the errors thus introduced. Relative heats calculated from adhesion tension data agree satisfactorily with those determined experimentally, and the same is the case for absolute heats of wetting on the basis of an assumed area for the gel. The above facts indicate that adhesion tension values determined by displacement pressure measurements are probably correct and that adhesion tension and free energy of immersion are numerically the same. T. H. P.

3031. Heat of Immersion of Silica Gel in Various Petroleum Substances. R. W. Stenzel. *Am. Chem. Soc., J.* 54. *pp.* 870–876, *March*, 1932.—The retention of oil by sands was investigated, and as a means of arriving at quantitative conclusions regarding the adsorption of oil the system silica-oil was examined. The heats of immersion of silica gel in cyclohexane, *n*-hexane, *n*-decane, benzene, toluene, CCl_4, $CHCl_3$, water, methyl and ethyl alcohols, and *n*-butyl mercaptan were measured. The results indicate that the hydrocarbons investigated form three groups, paraffin and naphthene hydrocarbons give low heats of immersion, the aromatics an intermediate value, and the alcohols and sulphur compounds do not differ greatly from water. The heats of immersion are considered to give the best indication of the capillary characteristics of such solids. F. J. B.

3032. Dielectric Behaviour of Emulsions. A. Piekara. *Kolloid Zeits.* 58. *pp.* 283–285, *March*, 1932.—The apparatus employed is described. Emulsions in liquids of low and high dielectric constant are investigated. The Clausius–Mossotti formula is employed, and the discussion centres round the dipole-effect. J. K.

3033. Dielectric Solvation of Disperse Systems. N. Marinesco. *Kolloid Zeits.* 58. *pp.* 285–294, *March,* 1932.—The present work refers to the determination of the molecular weight of colloids according to the anomalies of the dielectric dispersion. It is pointed out that the study of lyophilic colloids is of industrial as well as of biological importance. The present work extends to a determination of the quantity of liquid bound by hydrate formation to a given weight of soluble and insoluble particles. The subject is first theoretically investigated and then experimentally on the albumens. J. K.

3034. Nature of the Chemical Bond. Part III. Transition from One Extreme Bond Type to Another. L. Pauling. *Am. Chem. Soc., J.* 54. *pp.* 988–1003, *March,* 1932.—This paper continues the discussion of Part II [see Abstract 1026 (1932)] and, after dealing with the properties of substances containing ionic and electron-pair bonds, it is shown that the transition from one extreme bond type to another could take place continuously in some cases (when the normal states for the two extremes have the same number of unpaired electrons), and not in others. A method of treatment of bond type based on electronic energy curves is developed, whose application shows the normal alkali halide molecules to be essentially ionic. HF is large ionic, while HCl, HBr and HI contain electron-pair bonds. The normal state of CO corresponds to both structures, $:\dot{C}::\ddot{O}:$ and $:C:::O:$, with the latter predominant. Some general statements based on observed magnetic moments are made relative to the types of bonds formed by metals of the transition groups. H. H. Ho.

3035. Oxidation of Methane and the Function of Surfaces in Gaseous Reactions. H. W. Thompson and C. F. Kearton. *Chem. Soc., J. pp.* 933–941, *March,* 1932.—It has recently been shown by Neumann and Serbinoff that methane-oxygen mixtures behave like those of oxygen and hydrogen in that there exists at low pressure a critical pressure region for spontaneous inflammation, while at higher pressures a measureable chain reaction is observed, which ultimately passes into explosion at the highest pressures. The experiments now reported are stated to be of a preliminary nature, but are communicated in view of Neumann and Serbinoff's paper. It is found that methane-oxygen mixtures cease to explode with a spark if the pressure is below a certain limit, the value of which depends upon the composition of the mixture and upon the presence of inert gases. The inert gases in general increase the inflammability of methane-oxygen mixtures, the explanation being that they prevent the diffusion of active centres to the vessel walls, where deactivation occurs. T. B.

3036. Oxidation of Phosphorus Vapour at Low Pressures in Presence of Platinum and Tungsten. H. W. Melville and E. B. Ludlam. *Roy. Soc., Proc.* 135. *pp.* 315–333, *March* 1, 1932.—The action of hot filaments of platinum and tungsten on mixtures of phosphorus vapour and oxygen at pressures smaller than the lower explosion limit has been investigated in some detail. With platinum, the reaction velocity is conveniently measurable at about 200° and is directly proportional to the oxygen pressure. Argon is without influence and no glow is emitted during the oxidation which probably occurs at the platinum surface. With the tungsten filament at 500° C. the rate of reaction can be conveniently

measured and is proportional to the pressure of the oxygen and of the phosphorus, being increased by using wider reaction tubes and by the presence of neon and argon. A green glow accompanies the progress of the reaction and the apparent heat of activation is 16 kg. cal. These facts are summarised in the equation $-dp_0/dt = kp_P p_0\left(1 + \frac{\mu p_X}{p_P + p_0}\right)d^2 . e^{-U/RT}$, where p_P, p_0 and p_X are the pressures of phosphorus, oxygen and inert gas, k is a constant, $\mu = 0{\cdot}46$ for argon and $0{\cdot}20$ for neon, d is the diameter of a cylindrical reaction tube, U = 16 kg. cal. The reaction probably starts on the tungsten surface, is propagated through the gas phase and ends on the wall of the reaction tube. Gold, silver and molybdenum behave similarly to tungsten. H. H. Ho.

3037. Photosensitised Explosion of Hydrogen and Oxygen by Chlorine. R. G. W. Norrish. *Roy. Soc., Proc.* 135. *pp.* 334–348, *March* 1, 1932.—It is shown that hydrogen and oxygen can be exploded by the photosensitive action of chlorine, using light from the mercury-vapour lamp passed by glass. Temperatures between 25° and 340° C. were investigated, using a mixture of $(2H_2 + O_2)$ at constant molar concentration. For each particular temperature, other things being kept constant, there exists a sharp limit of pressure of chlorine, above which the explosive combination of the hydrogen and oxygen occurs, and below which the hydrogen and chlorine unite by a slow reaction to form hydrogen chloride. The mechanism of the explosion is not of the same type as that of the photosensitised explosion of hydrogen and oxygen by ammonia (Haber), since it can be made to take place at room-temperature. The limiting pressure of chlorine is very strongly dependent on temperature, and it increases rapidly as the lower temperatures are approached. The photosensitising function of the chlorine cannot be solely attributed to the initiation of reaction centres for the hydrogen-oxygen reaction, and an hypothesis is suggested according to which some element of the system is first raised adiabatically in temperature by the photochemical union of the hydrogen and chlorine. If this temperature reaches the "instantaneous" explosion temperature of the hydrogen and oxygen, explosion will be propagated from this point. If not, the heat will be dissipated and manifested as a Draper effect when conductivity equilibrium is attained. No explosion between hydrogen and chlorine was ever obtained. A quantitative expression based on this hypothesis is derived and shown to be in agreement with the experimental results. H. H. Ho.

3038. Lattice Energy and Photochemical Decomposition of Silver Halides. Part II. S. E. Sheppard and W. Vanselow. *Zeits. f. wiss. Phot.* 30. *pp.* 273–311, *March*, 1932.—Theoretical. The significance of the lattice energy for the absorption of light and photochemical decomposition of a crystal is discussed; the application of Sommerfeld's "electron gas" theory of metals to photoionisation in ionic crystals is criticised, and Pauling's postulate, based upon this theory, of an "electron affinity" of crystals is analysed, and certain limitations are indicated. By substituting for this "electron affinity" the lattice potential resulting from ionisation, better agreement is obtained between the observed and calculated wave-length limits of the absorption band. It is suggested that the deformation of anions by kations having a larger external electron shell tends to diminish rather than to increase the width of the absorption band. H. F. G.

3039. Theory of Coprecipitation. Formation and Properties of Crystalline Precipitates. I. M. Kolthoff. *J. Phys. Chem.* 36. *pp.* 860–881, *March,* 1932.—It is pointed out that impurities in crystalline precipitates are due to coprecipitation or post-precipitation. In real coprecipitation, in which impurities form imperfections in the crystal, the adsorption of foreign ions during growth of the particles is of primary importance. It is observed that a kation or anion coprecipitation may be expected according to the thermodynamic potential of the precipitate during growth. Reference is made to the Paneth-Fajans precipitation rule and also to v. Weimarn's expression of the relation between the speed of formation of precipitates and supersaturation. A discussion is given on filterability and properties of a flocculated colloid. J. K.

3040. Heats of Formation and — M/N Ratios. G. B. Heisig. *J. Phys. Chem.* 36. *pp.* 1000–1005, *March,* 1932.—The condensation of the saturated hydrocarbons is shown to be endothermal and the numbers of molecules condensing per ion-pair formed (— M : N ratios) small. The condensation of unsaturated hydrocarbons is exothermal and their — M : N values usually vary with their negative heats of formation from the elements and their standard states. With substances other than hydrocarbons, the value of the — M : N ratio increases with that of the negative heat of formation. From the heats of formation of compounds from their constitutional elements in their standard states it is possible to predict approximately the values of their — M : N ratios. T. H. P.

3041. Serial Number and Heats of Formation. W. A. Roth and G. Becker. *Zeits. f. phys. Chem.* 159. *Abt.A.* 1. *pp.* 1–26, *March,* 1932.—With the help of the results of various new determinations, curves connecting the heat of formation with the number giving the order of an element in a group have been drawn for the oxides, chlorides and chloride solutions of groups I to VI of the periodic system. The assumption that these curves represent simple linear relationships is justified in only rare cases. Moreover, many certain values do not lie on the curves. In a number of instances the curves allow values to be predicted and show that some values found in the literature are erroneous. The density of pure thorium is found to be $11{\cdot}7 \pm 0{\cdot}02$ at $21{\cdot}1°$. T. H. P.

3042. Physical Chemistry of Rhenium. W. A. Roth and G. Becker. *Zeits. f. phys. Chem.* 159. *Abt.A.* 1. *pp.* 27–39, *March,* 1932.—The heat of solution of $KReO_4$ at $16{\cdot}7°$ C. is $-13{\cdot}93 \pm 0{\cdot}03$ and at $21{\cdot}7° -13{\cdot}80 \pm 0{\cdot}03$ k.cal. per mol.; with $KMnO_4$ the variation with temperature is negligible, the value varying from $-10{\cdot}46$ to $-10{\cdot}62$ k.cal. as the dilution varies from 658 to 3887. The heat of solution of Re_2O_7 varies largely with the dilution and for infinite dilution is $+13{\cdot}20$ k.cal. The heat of neutralisation of $HReO_4$ aq. at infinite dilution is $+13{\cdot}5 \pm 0{\cdot}1$ k. cal., which is quite normal. At constant pressure the heat of formation of Re_2O_7 is $+295 \pm 2$ k.cal. and that of red Re_2O_5, $+169 \pm 10$ % at about 20°. The heat of formation of $KReO_4$ from its elements is calculated to be + 262 k.cal. As regards conductivity in solution, $KReO_4$ and $HReO_4$ show normal behaviour, the latter being a strong acid. The mobility of the ReO_4 ions at 18° is 44 ± 1, which fits well into the curve for XO_4' ions. The saturation concentration of $KReO_4$ at 18° is $0{\cdot}0329\ N$. T. H. P.

3043. Quartz Electrodes. Part I. B. v. Lengyel. Part II. B. v. Lengyel and T. Matrai. *Zeits. f. phys. Chem.* 159. *Abt.A.* 2–3. *pp.* 145–160, *March, and* 159. *Abt.A.* 5. *pp.* 393–402, *April,* 1932.—The

potential of quartz glass was measured against a series of electrolytes in aqueous solutions. The electrolytes used were LiCl, NaCl, KCl, $CaCl_2$, $SrCl_2$, $BaCl_2$, $AlCl_3$, $LaCl_3$, KBr, KNO_3, K_2SO_4, and also carbamide and ethyl alcohol. The potential is found to be defined from a lower limit of concentration upward, by the kation of the electrolyte. The lower limit is a function of the valency. The anions and non-electrolytes are without influence on the potential. Theoretical considerations show that the potential has the character of galvanic potential which exists between a solution and an adsorption layer formed on the solid phase. In Part II acid-alkali cells containing HCl, and $HClO_4$, LiCl, NaOH, and KOH were prepared over a range of concentrations, and up to higher concentrations than those previously investigated. The log . *c*H-voltage curve shows a minimum for 1 *N* acid and a maximum for 0·01 *N* alkali. The maximum is general for all alkalies investigated, the position of the minimum is modified by the kation present in the alkaline solution. F. J. B.

3044. Stick Antimony Electrode. L. R. Parks and H. C. Beard. *Am. Chem. Soc., J.* 54. *pp.* 856–864, *March*, 1932.—The preparation and calibration of the stick antimony electrode for use in the determination of pH values is described. It was found that when used in conjunction with a vacuum tube potentiometer, constant and reproducible readings are obtained. Stirring of the solution or bubbling of a gas through it causes a deviation of the values from the theoretical calculated values. The electrode in an unstirred solution in contact with air at equilibrium with antimony and antimony trioxide gives correct measurements of pH values between the limits of pH = 2 to 7 inclusive. The value of E with this electrode, measured against the normal calomel electrode, was found to be $E = +0{\cdot}030 + 0{\cdot}5915$ pH. F. J. B.

3045. Quinhydrone Electrode. Olive M. Lammert and J. L. R. Morgan. *Am. Chem. Soc., J.* 54. *pp.* 910–918, *March*, 1932.—The reproducibility of the quinhydrone electrode prepared with platinum, gold and graphite was studied in a series of solutions of hydrochloric acid, nitric acid, acetic acid, sulphuric acid and phosphoric acid, with and without the addition of the salts of each of the acids. The results indicate that the quinhydrone half-cell makes an excellent secondary standard, as it gives extremely precise results when used with discretion. The reproducibility in the system under investigation should be studied before it is used as a working electrode. F. J. B.

3046. Effect of Pressure Upon the E.M.F. of the Weston Standard Cell. T. C. Poulter and C. Ritchey. *Phys. Rev.* 39. *pp.* 816–820, *March* 1, 1932.—Several specially designed Weston standard cells have been constructed and subjected to large hydrostatic pressures. The cell cases were made of glass, beeswax or rubber and the e.m.f. measured at pressures from 1 to 12,000 atmospheres. Such pressures have the effect of increasing the e.m.f. only by a small fraction. AUTHORS.

3047. Iodine Accumulator. F. Boissier. *Comptes Rendus*, 194. *pp.* 1069–1072, *March* 21, 1932.—The cell consists of a cylindrical zinc vessel, forming the negative pole, coated outside with insulating material; inside is a cellulose diaphragm, between which and the central graphite rod (positive pole) is porous material, *e.g.*, charcoal powder, saturated with solution of ZnI_2. On charging the reaction is $ZnI_2 = Zn + I_2$, reversed on discharge. The specific capacity is 60 Ah per kg. total weight; e.m.f.

of charge 1·25–1·35 volts, of discharge about 1·15 volts, a suitable period for discharge is 10 hrs.; efficiency 70–80 %; on open circuit there is a very slow formation of ZnI_2 resulting in loss of capacity, but so slow as to be negligible under most circumstances. C. A. S.

3048. Improved Apparatus for Micro-Electroanalysis. B. L. Clarke and H. W. Hermance. *Am. Chem. Soc., J.* 54. *pp.* 877–885, *March*, 1932.—The two new cells described are claimed to be free from the usual objections to such apparatus, *viz.*, the long time required for complete deposition; structural fragility; disparity of size and shape between the electrodes, which prevents simultaneous kathodic and anodic deposition; absence of a satisfactory method of agitation; and difficulty in washing the electrodes. One cell is designed for use with small quantities of liquid, and has cylindrical, platinum gauze electrodes of height 15 mm. and diameter 9 and 18 mm., respectively; the second cell is intended for use when the volume of solution is large compared with the concentration of the metal to be determined and cannot be reduced owing to high salt concentration. Details are given of the determination with the small apparatus of traces of nickel, tin and zinc, and, with the large apparatus, of the determination of traces of zinc in aluminium salt solutions, of lead in zinc and nickel salt solutions, of copper in water and in nickel salt solutions, and of impurities in " chemically pure " reagents. H. F. G.

3049. Photographic Method of Recording Reactions between Electrolytes. P. Jolibois and G. Fouretier. *Comptes Rendus*, 194. *pp.* 872-874, *March* 7, 1932.—A capillary tube, bent so as to act as an agitator, through which by centrifugal force a sample of the reacting mixture is continuously driven, forms part of one circuit, enabling the conductivity of the mixture to be continuously recorded. The solution to be added is in a burette with an arrangement whereby the air pressure above the liquid varies proportionately to the amount of liquid that has flowed out; change in this pressure moves a column of mercury into which a platinum wire dips, thus altering the resistance of a second circuit. [See following Abstract.] C. A. S.

3050. Photographic Record of pH in Liquid Reactions. P. Jolibois and G. Fouretier. *Comptes Rendus*, 194. *pp.* 1072–1074, *March* 21, 1932. The system used is: HgCl electrode | liquid under examination | hydrogen or quinhydrone electrode; to diminish resistance the hydrogen electrode, consisting of platinum foil, is placed in a reversed bell jar, while the surface of the mercury (1 $cm.^2$) forming the HgCl electrode is powdered over with HgCl and covered with agar jelly saturated with KCl, and this again with a thin porous plate of alundum; the galvanometer circuit includes a resistance of 50,000 ohms. The quantity of added reagent is measured as previously described [see preceding Abstract]. The method is illustrated by the neutralisation of H_3PO_4 aq. with NaOH aq. C. A. S.

3051. Quantitative Limiting Law of the Viscosity of any Simple Strong Electrolyte. H. Falkenhagen and E. L. Vernon. *Phys. Zeits.* 33. *p.* 140, *Feb.* 1, 1932.—If η_γ is the viscosity of a simple electrolyte at the concentration γ mol. per litre and η_0 that of the pure solvent, the value of η_γ at limiting dilution is given by $\eta_\gamma = \eta_0(1 + A\sqrt{\gamma})$ [see Abstract 1456 (1932)]. A complicated equation is given for A in terms of the equivalent conductivities of the ions, the valencies of the ions, the

dielectric constant of the solvent and the absolute temperature. By means of this equation the values of A for a number of electrolytes are calculated and are found to be very small. Jones and Talley's method for the accurate measurement of the viscosity of solutions with the help of a photoelectric cell should furnish a means of checking the authors' theoretical law. T. H. P.

3052. Frequency Dependence of the Dielectric Constants of Dilute Strong Electrolytes. H. Falkenhagen and E. L. Vernon. *Phys. Zeits.* 33. *pp.* 218–221, *March* 1, 1932.—It has recently been shown experimentally [see Abstract 1457 (1932)], what had hitherto been deduced theoretically, that the loose union between the ions of a strong electrolyte leads to an enlargement of the dielectric constant, which also exhibits a dependence upon the frequency of the alternating field. In the present paper this frequency dependence is discussed and an interpolation table calculated which permits the quantitative examination of dispersion phenomena. Data for the chlorides of potassium, magnesium and lanthanum and for magnesium sulphate are included. H. H. Ho.

3053. Calorimetric Measurement of the H.F. Conductivity of Electrolytes. A. Deubner. *Phys. Zeits.* 33. *pp.* 223–227, *March* 1, 1932.—Two calorimetric methods are described for the comparison of the h.f. conductivities of two electrolytes of similar conductivity at low frequencies. The one method gives results which are accurate to 0·1 % and confirm those obtained previously in another way. Preliminary experiments have been made with the second method, of which the principle is described. T. H. P.

3054. Influence of the Surface Condition of Electrodes on Current Conduction in Dielectric Liquids. H. Edler and C. A. Knorr. *Zeits. f. phys. Chem.* 158. *Abt.A.* 5–6. *pp.* 433–440, *Feb.*, 1932.—It is shown that the current-voltage characteristic of a pure thiophene-free benzene, when platinum electrodes are used, is dependent on the hydrogen content of the electrodes. H. H. Ho.

3055. Migration of Ions in Rock-Salt Crystals. F. Bandow. *Ann. d. Physik*, 12. 3. *pp.* 385–400, *Jan.* 8, 1932.—The electric and thermal migration of silver ions in rock-salt crystals was investigated by a phosphorescence method. Thus a new way is opened for more refined examination of these processes. Special arrangement of the electrodes enabled separation to be made between the electric and thermal migration. The connection of these researches with earlier and later work is discussed. The emission of phosphorescent NaCl was investigated by a spectral method. J. J. S.

3056. Conductivity of Silver Sulphides. W. Jost. *Zeits. f. phys. Chem.* 16. *Abt.B.* 2–3. *pp.* 129–142, *March*, 1932.—Discusses the difficulty of explaining the large conductivity of $a\mathrm{Ag_2S}$ and describes measurements of its value under varying conditions. The results confirm those of Tubandt and Reinhold. By forming mixed crystals containing $\mathrm{Cu_2S}$ the conductivity is reduced in a sulphur-free atmosphere as well as in the presence of sulphur. It is suggested that the copper ions in these crystals have a much smaller mobility than have silver ions in silver sulphide, and it is hoped that this will explain the discrepancies in conductivity measurements of silver sulphide and also in diffusion experiments. J. E. R. C.

3057. Electrophoresis of Agar-Gold Sols. E. B. R. Prideaux and F. O. Howitt. *Faraday Soc., Trans.* 28. *pp.* 79–83, *Feb.*, 1932.—Agar, which is a polygalactose containing calcium and the sulphuric group, is frequently used as a support for dilute aqueous solutions of electrolytes, so that its electrochemical characteristics are of importance. The available chemical and physico-chemical data indicate that agar is a calcium sulphuric ester of a hemicellulose, the cyclic structure of this being responsible for the power of gelation, which is lost when the agar is hydrolysed by hot acid. The negative charge known to exist on agar is due to partial dissociation of the calcium ions which are coordinated to the molecule. The charge so produced on the residue or ionic micelle remains constant over moderate variations in [H·] or [OH′], as is shown by the comparatively slight effect of these ions on the viscosity ratio and more directly by the constancy of the electrophoretic velocity in solutions of variable [H·]. The absence of any appreciable amphoteric character is thus demonstrated and concurrently the suitability of agar as a support in investigating ionic diffusions of dilute acid and alkali. T. H. P.

3058. Action of Electric Field on Gelatin: Effect of Indicators. Suzanne Veil. *Comptes Rendus*, 194. *pp.* 454–456, *Feb.* 1, 1932.—An electric field deforms a gelatin film in the form of an undried gel, throughout the whole space between, and not merely near, the electrodes. Incorporation in the gelatin of various indicators, covering a range of pH from 0·15 to 13·0, shows abrupt changes of pH at various places, which appear to be the immediate cause of the deformations. [See Abstract 1466 (1932).] C. A. S.

3059. Boundary Conditions in Cataphoretic Measurements. J. N. Mukherjee. *J. Phys. Chem.* 36. *pp.* 595–603, *Feb.*, 1932.—Reference is made to the work of Burton, Whetham, Freundlich and Kruyt. The object of the present investigation is to determine experimentally the suitability of a given liquid for producing satisfactory boundary conditions. It is observed that the usual procedures for measuring cataphoretic speeds which avoid measurements of the potential gradient across the boundary are unreliable. It is pointed out that the ultrafiltrate, except when the colloid contains considerable quantities of free electrolytes, is unsuitable as an upper liquid for producing the boundary. J. K.

3060. Electrolytic Valve Action. Part III. Dielectric Constants of the Protective Al_2O_3 Layer. Part IV. Flow Mechanism in the Protective Layers of Valve Metals. A. Güntherschulze and H. Betz. *Zeits. f. Physik*, 73. 9–10. *pp.* 580–601, *Jan.* 8, 1932.—Measurement of the dielectric constant of the protective Al_2O_3 layer by three methods, two only of which are exact methods, gives the mean value $\epsilon = 7{\cdot}45$, whereas that of corundum or precipitated alumina is 12–12·3. It is assumed that, in the first case, the alumina is compacted and thus exhibits a lowered displaceability of the ions, as it is formed under a pressure of 400 atmospheres and in an electric field of 9 to 10 million volts per cm. The protective layers age during the first hours after formation, with the result that with constant strength of field the residual current falls. For the same age and field but different thicknesses of layer and voltage, the current is the same. The current-voltage curves follow different courses with falling and rising voltages, this indicating an effect of the space charges in the layer. With Al and Bi these curves curve regularly from

zero onwards, but with Sb the curve is for some distance rectilinear, as it is with Ta from 0 to 40 % of the formation voltage. With Zr this rectilinearity extends to 80 % and with W to 95 % of such voltage. With rise of temperature but constant field the current increases exponentially. During the formation the current consists partly of electrons and partly of ions, but, with very small formation-current densities, virtually only electrons form the current. With rising current density the proportion of ionic current increases to an almost constant value, which is independent of the electrolyte so long as no secondary disturbance is introduced by solubility of the valve metal. With high current densities, the ion current amounts to 84 % of the total current for Al, 36 for Ta, 62 for Sb, 64 for Bi, 48 for W and 48 for Zr. The high field-strengths necessary are explainable in two ways: (1) the resistance of the layer may be so high that strong fields are required to force the electrons and ions through it, or (2) this resistance is so small that only a fraction of the field-strength is necessary for this purpose, the bulk going to liberate the electrons and ions from the electrolytes at the boundary between protective layer and electrolyte. Both explanations are discussed. [For Parts I and II see Abstracts 2897 (1931) and 666 (1932).] T. H. P.

3061. Chemical Nature of Oxide Layers Formed on Aluminium, Zirconium, Titanium and Tantalum by Anodic Polarisation. W. G. Burgers, A. Claassen and J. Zernike. *Zeits. f. Physik*, 74. 9–10, *pp.* 593–603, *March* 3, 1932.—With aluminium, gravimetric analysis showed that the oxide layer formed by anodic polarisation in aqueous solution (borax-boric acid) was practically pure Al_2O_3, the water content being very small. X-ray photographs with the oxide showed the Al_2O_3 as present in a form closely similar to the cubic γ-Al_2O_3, although evidence for an effect of forming conditions on the chemical and crystallographic nature of the oxide layer, was obtained. For zirconium the X-ray analysis showed the oxide to be monoclinic ZrO_2 (baddelite modification); for titanium, tetragonal TiO_2 (anatase modification), and for tantalum, Ta_2O_5. W. S. S.

3062. Electrolytic Overvoltage. P. Sederholm and C. Benedicks. *Zeits. f. Elektrochem.* 38. *pp.* 77–86, *Feb.*, 1932.—The phenomenon of overvoltage is shown to be influenced by surface tension and to depend upon the geometrical configuration of the electrode. The overvoltage of hydrogen was determined on a carefully polished electrode with a sharply defined curvature, the measurements were carried out on mercury electrodes, which possessed the ideal smooth surface, on platinum, silver and a silver alloy. The results of the measurements show that the overvoltage is a function of the curvature of the electrode. The overvoltage is expressed by the equation $\epsilon = k \,.\, \log \,.\, a + k \,.\, \log \,.\, (1 + n \,.\, 1/r)$, where the first expression denotes the overvoltage for a plane and the second for a curved electrode. F. J. B.

3063. Hydrogen Overvoltage with Alloys. H. Flood. *Zeits. f. phys. Chem.* 159. *Abt.A.* 2–3. *pp.* 131–134, *March*, 1932.—The overvoltages shown by alloys are discussed from the standpoint of their space lattice structure and the theory of crystal growth put forward by Stranski. A distinction is drawn between heteropolar and homopolar crystals, and the phenomenon of overvoltage is considered as a consequence of the lattice arrangement. F. J. B.

3064. Electrolytic Reduction of Aromatic Ketones. Part I. S. Swann, Jr. *Univ. of Illinois Eng. Exp. Sta., Bull.* 236. [14 *pp.*], *Oct.*, 1931.—Benzophenone was electrolytically reduced in an aqueous solution containing sulphuric acid. Electrodes of cadmium, tin, bismuth, mercury, aluminium, zinc, carbon, nickel, copper and iron were employed as kathodes. The main product of the reduction was benzpinacone, some *s*-tetraphenylethane was formed when bismuth, aluminium, mercury, carbon, nickel and copper kathodes were employed. F. J. B.

3065. Electrolysis of Molten Alkali Nitrites. M. Centnerszwer and J. Szper. *Acad. Polonaise Sci. et Lettres, Bull. No.* 4–5*A*. *pp.* 352–363, *April–May*, 1931. *In French.*—With an iron anode in the form of a ring around the copper kathode gas is immediately evolved at both electrodes, and a mixture of $NaNO_2$, Na_2O and $NaNO_3$ formed, the density and melting point increase with amount of Na_2O, until finally explosion occurs; the voltage rises from 2–3 to 7. If the kathode is cooled a little Na is detectable. Collecting the kathode and anode gases separately, pure N_2 is formed at the kathode: $6Na + 2NaNO_2 = 4Na_2O + N_2$; but the yield varies irregularly with time, a part of the Na formed dissolving in the $NaNO_2$, and reacting violently when a certain concentration is reached. This is confirmed by the violent reaction occurring on adding Na to molten $NaNO_2$. The result is independent of the nature of the kathode, but the best yield in Na_2O is with nickel or iron, other metals being attacked. At the anode at first pure NO, then $NO + NO_2$ is evolved: $NO_2 + NaNO_2 \rightleftharpoons NO + NaNO_3$; this is an equilibrium reaction, the equilibrium mixture at 315° containing 0·5–5·6 % $NaNO_3$. All materials used for the anode were more or less attacked—iron least. With KNO_2 results are similar, but evolution of N_2 at the kathode is more regular, and pyrex glass as a container is more severely attacked. C. A. S.

3066. Electrolysis of Molten Sodium Metaphosphate. M. Centnerszwer and J. Szper. *Acad. Polonaise Sci. et Lettres, Bull. No.* 4–5*A*. *pp.* 364–368, *April–May*, 1931. *In French.*—$NaPO_3$, m.p. 640°, can be electrolysed in a porcelain crucible, the least attacked material for the anode being nickel, for the kathode iron, but in any case the latter is considerably attacked. The results are in accord with the following equations: $NaPO_3 = Na + PO_3'$; $5Na + NaPO_3 = 3Na_2O + P$; $2PO_3' = P_2O_5 + O$; followed by $Na_2O + NaPO_3 = Na_3PO_4$; and $2NaPO_3 + P_2O_5 = Na_2P_4O_{11}$, with other reactions according to the material of the electrodes. C. A. S.

3067. Isolation of Heavy Metals by Electrolysis of Fused Electrolytes. Part III. F. Sauerwald. *Zeits. f. Elektrochem.* 38. *p.* 76, *Feb.*, 1932.—Continuing previous work [see Abstract 2244 (1928)], the use of electrodes other than carbon electrodes for the electrolysis of fused electrolytes is considered. The use of a water-cooled copper tube as anode for the electrolysis of fused iron silicate is described. The iron crucible and the separated iron serve as the kathode. F. J. B.

3068. Strains in Electrolytic Copper Deposited in Presence of Gelatin. P. Jacquet. *Comptes Rendus*, 194. *pp.* 456–458, *Feb.* 1, 1932.—The effect of adding gelatin (0·5–500 mg./l.) to the solution of cupric sulphate (150 g./l. of $CuSO_4$, $5H_2O$) with sufficient sulphuric acid to make the pH 0·85) has been examined by the method previously described [see Abstract 4358 (1931)]. As the amount of gelatin increases the con-

traction at first observed decreases; with 50 mg./l. it is preceded by dilatation, this gradually increases with increasing amounts of gelatin until with about 200 mg./l. the net result is dilatation, which thereafter further increases. With less than 50 or more than 250 mg./l. the deposit is matt, with intermediate amounts it is brilliant. [See also Abstract 3348 (1928).] C. A. S.

3069. Electrochemical Method of Following Changes in Gelatin Solutions as a Function of Time. P. Jacquet. *Comptes Rendus*, 194. *pp.* 870–872, *March* 7, 1932.—Curves relating the contraction at the kathode resulting from electrolysis for 10 min. of various cupric sulphate solution to which had been added equal amounts (35 mg./l.) of gelatin dissolved in three different ways, to the time the solution had stood after addition of the gelatin, show great sensitiveness to the method of preparing the gelatin solution. [See Abstracts 2853 (1928) and preceding Abstract.] C. A. S.

3070. Transference Number of Cobalt Sulphate. R. C. Cantelo and E. C. Payne. *J. Phys. Chem.* 36. *pp.* 1045–1050, *March*, 1932.—The transference number of cobalt ion in solutions of cobalt sulphate was determined over a range of concentrations of 0·233 to 3·994 *N*. The measurements were carried out at 25° C. The transference number varied from 0·396 to 0·149 in this range of concentrations. The value calculated from the ion conductance is 0·419. Excessive hydration of the cobalt kation is shown to be inadequate to explain the deviations of the transference numbers from 0·419. The assumption of a complex anion of the type $Co(SO_4)_2$ is considered to afford a more logical explanation of the variations. F. J. B.

3071. Electrochemical Behaviour of Gold in Hydrochloric and Hydrobromic Acid Solutions. G. Grube and T. Morita. *Zeits. f. Elektrochem.* 38. *pp.* 117–131, *March*, 1932.—It has been found from determinations of the current density-voltage curves of the anodic dissolution and kathodic deposition of gold in hydrochloric acid solutions of auric chloride that polarisation at the electrodes may be considerably reduced by increasing the temperature and the concentration of free acid. The depolarising influence of hydrochloric acid indicates that polarisation is not brought about by the complexity of the anions formed at the anode and discharged at the kathode, but is due more probably to surface films which are formed on the electrode, and consist of products of hydrolysis of hydrochlorauric acid. The equilibrium

$$3AuBr_2' \rightleftarrows 2Au + AuBr_4' + 2Br'$$

is studied and the following normal potentials at 60° are determined:

$$Au + 2Br' \rightleftarrows AuBr_2' + e, \epsilon_0 = 0{\cdot}96 \text{ volt};$$
$$Au + 4Br' \rightleftarrows AuBr_4' + 3e, \epsilon_0 = 0{\cdot}87 \text{ volt};$$
$$AuBr_2 + 2Br' \rightleftarrows AuBr_4' + 2e, \epsilon_0 = 0{\cdot}82 \text{ volt}.$$

In bromide solutions the polarisation relationships closely resemble those in chloride solutions. By electrolytic transference of gold in hydrobromic acid solutions the solution formed at the anode becomes strongly supersaturated with respect to univalent gold, so that secondary deposition of finely divided metal takes place to a greater extent than in chloride or other solutions. H. F. G.

3072. Electrolytic Dissociation. Part II. K. Fredenhagen. *Zeits. f. phys. Chem.* 159. *Abt.A.* 2–3. *pp.* 81–114, *March*, 1932.—Electrolytic solution or distribution numbers (P) may be mathematically and physically defined and are closely related to Nernst's electrolytic solution tensions, the only uncertainty concerning them being that, as with the solution tensions, only their relative values are determinable. The criticisms of Hammerschmid and Lange [see Abstract 4363 (1931)] on the author's previous paper [see Abstract 2515 (1931)] are answered and the following subjects are discussed: the occurrence of a contact p.d. between metal and metal in the measurement of e.m.f., and the significance of such p.d. in the thermodynamic calculation of e.m.f. in general and of P values in particular; the thermodynamic relationships between gaseous ions, gaseous atoms and solution ions; whether electrolytic dissociation is explainable by purely electrostatic forces or whether specific chemical forces must be utilised. **H. Hammerschmid** and **E. Lange**, in discussing this paper, attribute a decisive importance to the metal-metal contact p.d. in measurements of the e.m.f. of galvanic elements. The author regards this view as a purely theoretical speculation, as proof is lacking that such p.d. exists, and a number of experimental results indicate the contrary.

T. H. P.

3073. Coefficients of Ionic Distribution. Part II. Solubilities of Tetra-ethylsilane and Tetra-ethylammonium Halides in Various Solvents. N. Bjerrum and E. Józefowicz. *Zeits. f. phys. Chem.* 159. *Abt.A.* 2–3. *pp.* 194–222, *March*, 1932.—In order to test the formulæ deduced by Bjerrum and Larsson [see Abstract 3017 (1927)], the ionic distribution coefficients of tetra-ethylammonium halides have been measured by determining their solubilities in water, methyl and ethyl alcohols, acetone and benzene at 20° and 35°. Tetra-ethylmethane is a non-electric substance with molecular structure similar to that of the tetra-ethylammonium ion, but its preparation is extremely difficult. Use has therefore been made of tetra-ethylsilane, the distribution of which between vapour and liquid has been investigated at 20°, 35° and in some cases at 50° for the above five solvents. The experimental data are in accord with the theoretical considerations, but are not sufficiently exact to carry great weight in supporting these. T. H. P.

3074. Hydration of the Solute Ions of the Elements. L. H. Flint. *Washington Acad. Sci., J.* 22. *pp.* 97–119, *March* 4, *and pp.* 211–217, *April* 19, 1932.—The electrical conductivity in solution, the freezing-point depression, and the boiling-point elevation of salts of metals contained in the first quarter of the periodic classification have been examined as regards their relation to the degree of hydration of the solute ions. In general, all the measurements support the assumptions that an inverse integral relationship exists between the weight of the anhydrous ion and its degree of hydration, and that an orderly change of weight accompanies ionisation. In the second paper the treatment previously applied to the lighter elements has been extended to the heavier elements (vanadium to uranium). The hypothesis of an inverse integral relationship between the weight of the anhydrous ion and the degree of hydration appears to be valid for these elements, but it is possible that not all solute ions are hydrated. H. F. G.